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Directions for Collecting and Preserving Specimens of Dragonflies for Museum Purposes

BY

E. B. WILLIAMSON.

ANN ARBOR, MICHIGAN.

PUBLISHED BY THE UNIVERSITY.

DECEMBER 1, 1916. — 1924

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The publications of the Museum of Zoology, University of Michigan, consist of two series—the Occasional Papers and the Miscellaneous Publications. Both series were founded and are being supported by Dr. Bryant Walker, Mr. Bradshaw H. Swales and Dr. W. W. Newcomb, except that the cost of the illustrations and of distribution are borne by the University.

The Occasional Papers, publication of which was begun in 1913, serve as a medium for the publication of brief original papers based principally upon the collections in the Museum. The papers are issued separately to libraries and specialists, and when a sufficient number of pages have been printed to make a volume a title page and table of contents are supplied to libraries and individuals on the mailing list for the entire series.

The Miscellaneous Publications include papers on field and museum technique, monographic studies and other papers not within the scope of the Occasional Papers. The papers are published separately, and, as it is not intended that they shall be grouped into volumes, each number will have its own title page and table of contents.

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ALEXANDER G. RUTHVEN,
Director of the Museum of Zoology,
University of Michigan.

CONTENTS.

PAGE

The Collecting and Preserving of Imagoes 5

Dragonfly Habitats 5

The Collecting Net 6

Killing Bottles 6

The Collecting Case 6

Papering Specimens 9

Drying Specimens 11

The Packing of Papered Specimens 13

Pinning Specimens 13

Preserving Specimens in Alcohol 13

The Preservation of Nymphs 14

The Preservation of Nymphs and Imagoes for Histological and Cytological Studies 14

Collecting Manuals 15

ILLUSTRATIONS.

FIG. 1. Collecting Box 7

FIG. 2. Envelope for Papered Specimens 9

FIG. 3. Drying Box 12

DIRECTIONS FOR COLLECTING AND PRESERVING DRAGONFLIES FOR MUSEUM PURPOSES.

BY E. B. WILLIAMSON.

The methods of collecting and preserving dragonflies described in this paper are for the most part those which have been worked out by the writer in the course of several years of field work. No attempt has been made to try out the many kinds of collecting appliances on the market nor to experiment with all of the described methods, but an effort has been made to discover simple and yet adequate appliances and methods for the collecting and proper preservation of specimens of this most interesting group. These directions should, then, be considered as suggestions rather than as dogmatic rules.

THE COLLECTING AND PRESERVING OF IMAGOES.

Dragonfly habitats.—Years ago the writer heard Dr. Kellicott say that the way to get all of the rotifiers was to look in all the unlikely places,—the likely places would supply a great many, the unlikely places would complete the list. The same is true of all collecting. Visiting a stream at one point does not determine its Odonata fauna on that day. One may follow it with almost barren results for miles, till a sudden turn brings one on a rocky ripple, grass margined, with clumps of lizard-tail, and broken with patches of water-willow where untold numbers of multicolored and iridescent wings spring into view, a score or more species inviting one to the chase. Or a sunny meadow may rise, brush and forest girded, up the hillside from the brook you are following; along the edges of this meadow more than one rare dragonfly may be basking on the leaves of some bush or low tree. What has been said about visiting streams is also true of lakes. If the lake visited is small the entire circumference should be explored by the collector. For various reasons, such as temperature and soil differences, the inlets and outlets of the lake may differ more or less in their dragonfly species. Prevailing winds through centuries modify the shores of lakes, and one side may be found to be boggy and without a beach while the opposite shore may have a well defined gravel and sand beach, with consequent differences in both fauna and flora. If the lake is large, consideration of the above points should receive the collector's attention when selecting places to work. If one can spend several days along one stream or about some small marsh, the first day or two may profitably be spent in a general survey and in paying attention to the larger, free flying dragonflies, leaving for a later date the close searching of low vegetation and concealed nooks for the smaller, less agile and less readily discerned species. The last day or more may be given to same particularly interesting find of the preceeding days. Remembering, in conclusion, that it has been truly said of the dragonfly collector, "all things come to him who wades."

The collecting net.—The writer has tried only a few kinds of nets. For several years he has used what is known as "Our Own" patent landing net, a steel collapsing ring, which can be obtained from entomological supply companies. The frame used has the two steel sides each about 22 inches long. The bag is made of light bobinet (15 or 16 meshes to the inch) and when flat is about 22 inches long (deep). The edge of the open end consists of two narrow sleeves of stout muslin which slip over the steel sides which make the ring of the frame. This landing net is provided with a three jointed bamboo-handle, two joints of which make a handle of suitable length for insect collecting. This insect net is light, strong, and when not in use, may be conveniently packed or carried. Bags of several kinds, suitable for beating and dredging, for example, can be carried in the field and changes from one bag to another, or the replacing of a ripped bag, can be effected in a moment's time.

Killing bottles.—Of several ways of making killing bottles the most satisfactory has been to place potassium cyanide crushed to about the size of grains of corn over the bottom of the bottle selected; this is then covered with about a quarter of an inch of sawdust, over which is poured plaster of Paris mixed with water to the consistency of cream. The whole need not occupy over an inch and a quarter of the bottle,—less if one is fortunate in pouring in the plaster. The most convenient bottle I have found is the ounce morphine bottle. Four such bottles can be conveniently carried in the double side pockets of a coat or blouse. Smaller bottles can be made in the same way of straight glass vials four inches high and seven-eights of an inch in diameter. Such small bottles are valuable for killing pairs of smaller dragonflies or for particularly small and fragile species. Such vials are also of a convenient size for carrying alcohol or other preservatives in the field.

It goes without saying that miscellaneous collections of insects should never be dumped in the same killing bottle. The scales of Lepidoptera and the juices of various Orthoptera are especially objectionable, and none of these insects should go into the bottles containing dragonflies, or in which dragonflies will be subsequently placed unless the bottles are thoroughly cleaned in the meantime.

A killing bottle made as above described will sometimes "sweat." This moisture is ruinous to dragonflies. For this reason bottles should be made several weeks before they are intended for field use and all moisture should be guarded against by airing the bottle in the sun and packing the bottom with scraps of paper or cloth if necessary.

Specimens should be removed from the killing bottle as soon as they are dead or at frequent intervals. If the bottle is "strong" a short exposure may completely destroy the colors of many species. They must be removed to some convenient and safe receptacle in which to carry them till the day's collecting is over.

The collecting case.—The box here described has been used satisfactorily for several years in various climates and under varying collecting conditions. The pattern for this leather box is shown in the accompanying diagram (Fig. 1).

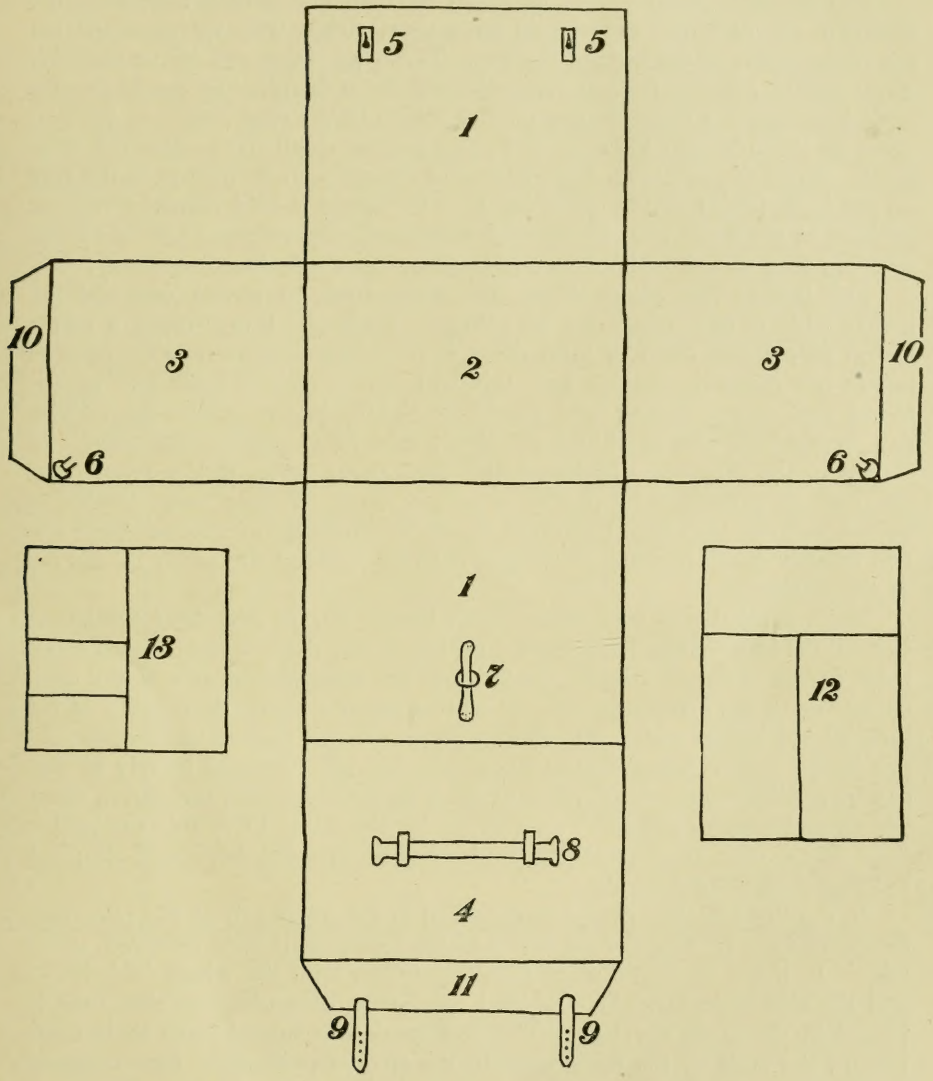

FIG. 1.—Collecting box; 1, side, about 8½ x 11 inches; 2, bottom, about 7½ x 11 inches; 3, end, about 7½ x 8½ inches; 4, top, about 8½ x 11 inches; 5, buckles in which two straps (9) on the top fasten; 6, rings for shoulder strap; 7, ring on strap, so it can slip up or down, in which to fasten snap attached to back of a belt; 8, handle on top of box, to carry when it is not over the shoulder; 9, short straps on flap (11) on top, to fasten in buckles (5) on side; 10, straps on end of box, to turn in and be covered by the top (4) when box is closed; 11, flap on top (4) of box; 12, compartments in the lower or bottom tin pan in the collecting box; 13, suggested compartments in the shallow pan (1 inch deep, 7 inches square) for the collecting box.

The shoulder strap should be about an inch and a half wide over the shoulder and at either end should have short straps with spring snaps for the rings shown on the ends of the box. The strap at one end of the shoulder strap should provide for varying adjustments in length. In the back of a wide belt, fasten a small spring snap to attach to the ring shown in the diagram on the side next the top. This ring is on a small strap, attached at its ends. When the box is on one's back and the snap on the belt is in the ring on the back (side) of the collecting box, the latter is held securely in place without at the same time interfering with one's movements. One may run or stoop over at will without having the box come tumbling in his way.

This leather box which stands 8½ inches high, 11 inches long and 7½ inches wide is now ready for its fittings. Have the tinner make a pan 4 inches deep which will just force down in it. Depending on how the harness maker has made the leather box, this will vary a little but the pan will be about 10¾ x 7¼ inches and should fit tightly in the leather box. This pan should have two partitions dividing it into three equal compartments as shown in the diagram. Make another pan about seven inches square and one inch deep divided by partitions as you wish. I have mine divided in halves, and one-half with two cross partitions dividing it into one larger and two smaller compartments. This pan must be made to slip easily in and out of the leather box.

Make a third pan also about seven inches square and deep enough to just fill the leather box when placed on top of the shallow pan, that is about three inches deep. A fourth pan is about the same size as one of the compartments in the first made pan. It will be about 4 inches deep and 7 inches long by 3½ inches wide. These four pans will just fill the leather box, the one in the bottom being firmly wedged in, the others fitting loosely so they can be readily removed. A piece of tin with turned edges, measuring about 7⅛ x 10⅝ inches, will serve as a cover for the box. Over this the leather flaps on the ends are turned and the leather lid brought down and strapped, holding everything securely.

In the three bottom compartments and in the other pan of the same size, carry ordinary envelopes (3⅝ x 6½ inches) with their flaps removed, set on edge. In these envelopes place your specimens with the wings folded back and the abdomens straight. Several specimens, depending on size, may be placed in the same envelope. The end specimens should have their heads toward the ends of the envelope. In the envelopes in these four compartments a large day's collecting can be carried home in perfect condition and in admirable shape for future papering or pinning. Some other form of collecting box may be used to suit the collector, but no better method I think can be devised for carrying home specimens than to place them in envelopes which are carried on edge. The time required to place them in the envelopes is more than saved by the admirable condition of the specimens when one comes to paper them.

In the shallow pan in the leather box the writer carries a pair of small pliers, fine tweezers for handling specimens, some vials of pins and alcohol, string, lead pencils, memorandum book and a small box or two for exuviæ. In the larger square pan is carried the lunch, some insect bags, etc. On the

return in the evening the lunch is usually replaced by a small turtle, a few small snakes, a set of bird's eggs, some seeds, leaves or flowers, or whatever of interest the day may have yielded. Pairing dragonflies, if it is desired to keep them together, are killed in smaller bottles and the pair put in an envelope by themselves, or, as taken from the net, the pair are impaled on a No. 1 insect pin, and later unpinned and placed together in an envelope. Large dragonflies such as the larger libellulines, Macromia, the aeschnines and gomphines may be carried home alive. Simply rotate the head once till the neck snaps, and place them in the envelopes. They will live a day or more in a comatose condition, expelling the contents of the alimentary canal. In the evening at home they can be killed in a cyanide bottle and papered

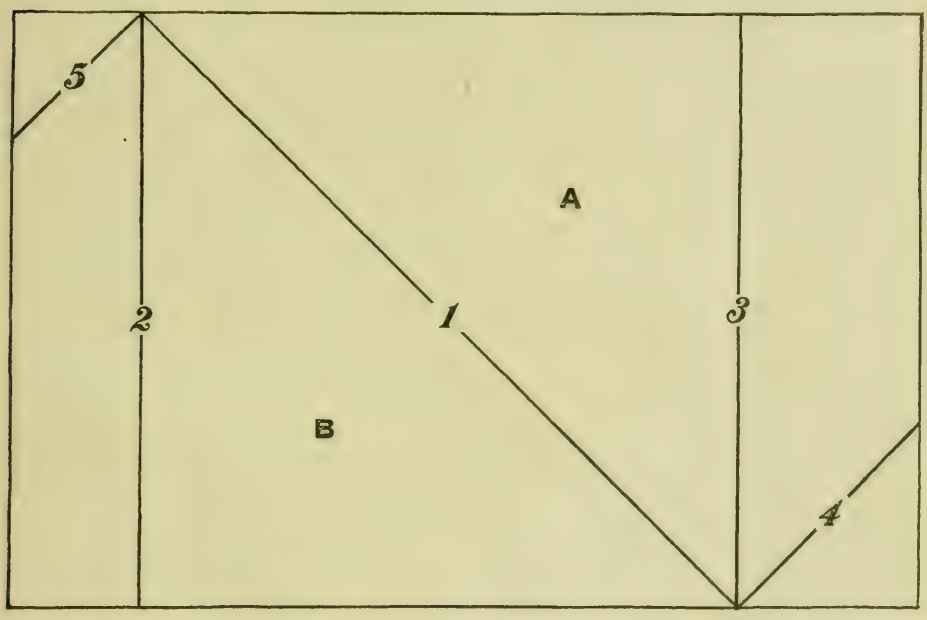

FIG. 2. Envelope for papered specimens.

at once, or they may be allowed to die naturally and then papered. Twisting the heads of large species will prevent their biting and possibly injuring the wings of other specimens if they are dropped into the cyanide bottle in the field.

With the specimens safely home, a piece of white oilcloth spread on a table, makes an ideal place for sorting, arranging and papering specimens. Personally the writer prefers to paper all of the material, later selecting from the dried specimens such as it is desirable to pin. As the conventional methods of pinning and expanding specimens have been so well explained by lepidopterists little will be said on the subject (see page 13).

Papering specimens.—The most convenient envelope is the usual three-cornered one made by folding a rectangular piece of paper as indicated, the folds to be made in the order shown, a and b being the inside of the envelope. Do not fold with a and b outside as the resulting envelope will

be different at the corners, and is less readily opened and closed. Nothing is more annoying in its way than to examine large series of specimens in papers folded some one way and some the other.

Envelopes may be obtained at any newspaper office. Have light newspaper stock cut in rectangles 2 x 3⅜ inches and 2¾ x 4⅛ inches, and have heavier newspaper stock cut in rectangles 3⅝ x 6 inches, 4¼ x 6½ inches, 5 x 7¼ inches, and so on to larger sizes if desired. The last named will paper a dragonfly nearly 5 inches long. Fold your envelopes before the collecting season or before a collecting trip. Cut strawboard corners the size of the folded envelopes, and bunch the envelopes in fifties, with a strawboard corner on either side, all held together by a small rubber band. Put these bundles under a weight or in a letter press for a few days. Nothing is more wasteful of time and energy than to make slipshod envelopes from day to day when the collecting should receive all one's energy, using for material old magazines, newspapers, discarded correspondence, etc., etc. The method here suggested provides uniform envelopes, well folded, of clean paper, unmarred by writing or printing, on which intelligible data can be written or stamped, leaving space for brief field notes or references to other fuller notes in a suitable note book. And they represent less loss of time and energy than the heterogeneous collection of half-folded waste paper in which too many collectors entomb objects of once animate nature for which they might well show more respect.

With the envelopes prepared nothing will save more time and energy than a collection of suitable rubber stamps or a small stamp in which the desired type can be set, and a small line dater. The data should include the place, the collector's name, and the date, to which may be added in writing any field observations. The ink used for the stamp should be one that will not fade or "run" if the envelope is moistened.

In papering material the first consideration is to prevent distortion of the specimen due to pressure by the envelope. The abdomen and especially the appendages are most likely to suffer. For specimens with dilated abdomens or wide spreading appendages, nothing is better than a bit of cord of suitable diameter fastened with a drop of glue on the inside of the envelope along its folded edge near one corner, the head of the insect resting at the other corner. Since dragonfly thoraces are usually larger than the abdomen and are relatively firm it is often well to paper two specimens of the same species in one paper, the heads at the corners and the abdomen of one above the other, not crossed, if the abdomens are long. So papered the thoraces will bear the pressure of the envelope and the specimens will have the abdomens and their appendages preserved without any distortion. Keep the abdomens straight and wings properly folded back together. In the case of libellulines especially see to it that the legs do not cover and conceal the accessory genitalia. When the specimen is in the envelope and the envelope has been carefully closed, fasten the corners down with a bit of gummed paper 1/16-3/32 of an inch wide and about ½ inch long fastened to the flap, at each acute corner of the envelope and around to the opposite side of the envelope. Avoid any pressure on the specimen in attaching these gummed

strips. This method of sealing the envelope is infinitely superior to the time-honored method of turning the corners. It requires less time, endangers less the contents of the envelope, is more secure, and facilitates the ultimate packing of the dried material. After papering, the envelopes should not be tumbled about till the specimens are thoroughly dry. Otherwise abdomens may be thrown up between the wings, may be crossed and constricted or bent at the point of crossing, or other damage may be done.

Drying Specimens.—As has been stated, in papering material the first consideration is to prevent distortion. The second point is to preserve as fully as possible, and that is often far too little at the best, the structures and the colors of the insect in life, or at least to dry it rapidly and thoroughly, and prevent a slow decomposition which would render the preserved specimen unduly fragile. In this connection it may be stated that it is unnecessary and undesirable to make a general practice of passing bristles or other supports through dragonflies' bodies if they have been properly dried. Bristles may be necessary in repairing broken specimens, but such specimens should be considered surgical cases, and this occasional heroic treatment should not be inflicted on all. Another reason for rapid drying is facility in handling a large number of specimens which once dried can be safely packed away, but which if undried and accumulating from day to day would form a serious obstacle to the movements of the collector.

If the amount of material collected is not large, if the collecting days are not continuous, and if frequent changes of locality are not made, papered dragonflies can be dried very well under ordinary conditions without recourse to artificial heat. At his home the writer arranges the papered material on large sheets of cardboard which are placed on tables in a dry room where the full sunlight can fall on them. As stated above, while drying the envelopes containing specimens must not be tumbled about. Rapidity of drying is essential to good color preservation, and is more readily obtained in some climates than others. In a humid climate artificial drying is necessary if good preservation is to be obtained. Artificial drying facilitates handling large quantities of material rapidly, prevents large accumulations of undried material which require the collector's attention, and seriously burden him if he wishes to make frequent moves to new localities.

After several experiments with differently constructed artificial driers, I have made one which seems to answer all the requirements. This is a tin box 15 inches high and 10 inches square, open at the top and bottom. Three sides are of tin without openings. The fourth side is open except for about 2 inches at the top and 1 inch at the bottom (where the tin of the adjacent sides is continuous), with the proper supports for 4 interchangeable drawers, each 3 inches high. The supports for these drawers are placed so the first drawer is just above the inch at the bottom of the box. Each drawer is about 3 inches deep and 10 inches square; the sides are of tin and the bottom of wire mesh, about 6 meshes to the inch; the top is open. These 4 drawers occupy the space between the inch of tin at the bottom and the tin about 2 inches wide at the top. A shallow pan of similar construction to the drawers is made to drop into the top of the box. When all the drawers are in place

the four sides of the tin box are enclosed. To the lower end of this box a tapering, heavy canvas funnel or chimney about 3 feet long is fastened. This must fit tightly over the bottom of the tin box and at the opposite end be tapered to go neatly over a small lantern using a 5/8inch wick. In use the tin box is hung at the proper height against the wall by cords attached to rings at the top of the box. So hung, with the lantern burning in the cloth funnel or chimney, and the drawers in the box, a warm current of air passes through the box and out the top. The bottom drawers are the warmest and

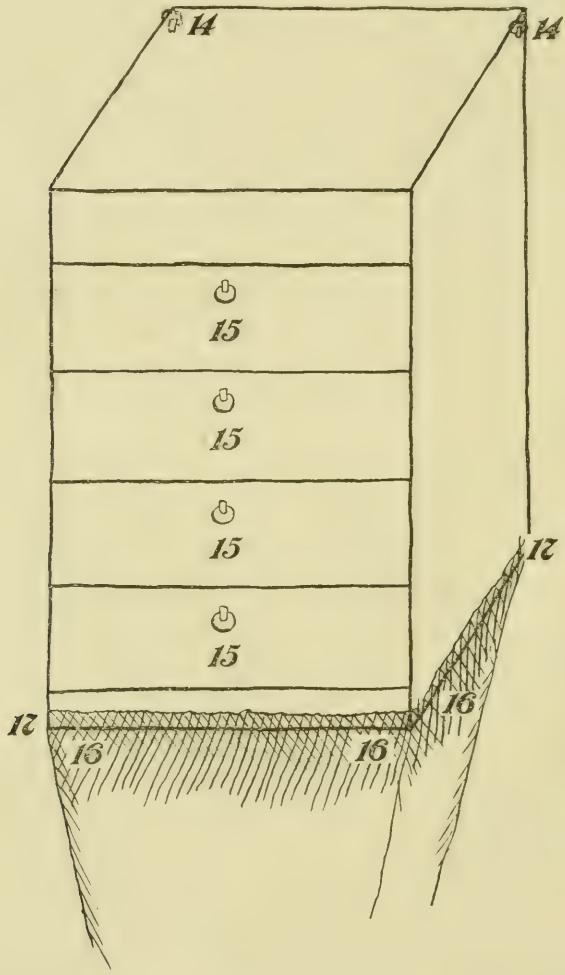

FIG. 3.—Drying box; 14, two rings by which drying box is suspended by cords against the wall; 15, four interchangeable drawers; 16 heavy canvas chimney, fitted closely around box; 17, short, sharpened, upturned wires fastened at each lower corner of the box, over which the canvas chimney (16) is hooked, to facilitate holding the chimney securely in place.

this should be borne in mind, larger species, or the most recently captured specimens being placed in the lower drawers. Place envelopes in the drawers upright or inclining, and resting on their long edge, but not piled up flat, as in the latter case the circulation of warm air about each envelope will be interfered with. Do not put all of one day's catch in one drawer, but, on the basis of size, distribute the papered specimens in two or more drawers. A little experience will teach one when the specimens can be safely removed for permanent packing. In actual practice the writer empties the drawers only as the acquisition of new material requires that room be made for it. Specimens are not injured if left for several days in the drier.

The length of time required to dry specimens is dependent on the size (bulkiness) of the specimens themselves, and on the atmospheric conditions. Small agrionines such as Argia and Enallagma will sometimes be dry at the end of 12 hours, and I have found bulkier things, such as the libellulines, dry in 24 hours.

The packing of papered specimens.—Cigar boxes make as convenient and safe receptacles for packing dried material as any other. If cigar boxes are dipped or otherwise thoroughly saturated with a mixture of equal parts of crude creosote and creolin their contents, if taken directly from the drying box, will be free from the attacks of ants and other pests. A small quantity of napthaline flakes should be placed in the bottom of the box and covered with a piece of paper or cotton wadding. Boxes should be treated with the creosote-creolin mixture several weeks or even months before specimens are put in them.

In packing material in boxes, put in pieces of cotton wadding at frequent intervals cut to the size of the box, building the box up in this way in layers. This will give a certain elasticity to the mass, and prevent shaking about, and the sheets of cotton so interspersed will prevent the envelopes packing and jamming together at one end of the box.

It is an easy matter to accumulate a lot of cigar boxes of the same size, and if this is done one can arrange a space for them in a trunk or suit case more advantageously than if boxes of various sizes and shapes are used.

Pinning specimens.—As has been said, this subject will not be discussed in detail, but one remark on pinning specimens may be permitted. The writer has long since ceased to relax specimens for pinning except in exceptional cases, such as those having highly or densely colored wings. In the great majority of cases the specimens are taken directly from the envelopes and pinned without any treatment, the Zygoptera vertically between the front wings with a smooth No. 1 pin, the Anisoptera laterally through the bases of the hind legs, close up to the body, with a No. 1 or No. 2 or rarely a No. 3 pin for the largest species. Specimens so pinned require less room and are in better condition for critical study. Of course this method is not recommended for material designed largely or solely for public display purposes.

Preserving specimens in alcohol.—The colors of dragonflies may be well or almost perfectly preserved in full strength alcohol. Such specimens should be placed in alcohol while alive or at once after being killed and the vials

or bottles of specimens kept in the dark. After a few days the alcohol in which they are preserved should be replaced with clean, full-strength alcohol.

THE PRESERVATION OF NYMPHS.

Mr. R. J. Tillyard recommends the following formula for preserving larvæ where preservation of internal parts is desired.

15 parts 98% alcohol.
6 parts formal.
2 parts glacial acetic acid.
30 parts distilled water.

Place larvæ in this alive. As soon as possible make ventral incision opposite mid-gut. After 24 hours preserve in 70% alcohol.

Professor James G. Needham, in reply to my inquiry about any special methods, wrote, "I simply use alcohol and, when particularly careful, change it a time or two within a few days after putting specimens in and endeavor to have it, when osmosis is complete, of a strength of 70-80%. Preservation of the nymphs is then entirely satisfactory. I have found formalin an abomination, as it does not penetrate and does make brittle. The glycerine mixtures make things greasy, so I have ended up by using the method that is simplified."

THE PRESERVATION OF NYMPHS AND IMAGOES FOR HISTOLOGICAL AND CYTOLOGICAL STUDIES.

The following notes on preservation of nymphs and imagoes for histological and cytological work have been kindly furnished by Dr. Philip P. Calvert of the University of Pennsylvania.

Larvæ and imagoes of Odonata may be fixed and preserved for study of internal organs as follows. Plunge the living insect into hot water, hot alcohol (30-50%) or hot Gilson's fixing mixture. The temperature should be 80°-90°C. Gilson's mixture is composed of nitric acid (46° strength) 78 cc., glacial acetic acid 22 cc., corrosive sublimate 95 grams, 60% alcohol 500 cc., distilled water 4400 cc. When the entire larva or imago is to be preserved for dissection, and not for histological or cytological work, hot water or hot alcohol (as above) will suffice. The insect should be left in them only until muscular movements cease, then withdrawn from the liquid, one or more slits cut through the chitin (according to the size of the specimen) in places where internal organs will not be injured, always taking care to cut no deeper than through the chitin and underlying hypodermis, and immediately placed in alcohol of greater strength than that employed for fixing. After one or more hours this alcohol should be replaced with stronger and so on until a strength of 70 or 75% is reached. When Gilson's mixture is used, the specimen should be (after cutting the slits) washed in water for an hour or more to remove the mercury salts.

When internal organs are desired for histological or cytological work, section-cutting, etc., the insect should be cut in pieces as it is allowed to fall into the killing fluid. This is for the purpose of affording more rapid

penetration of the fluid into the body cavity and the organs lying in it. In passing such material through alcohols of increasing strength as directed above, the transfer should be carried to 90 or 95% strength.

Permanent preservation of material for dissection should be in 70% alcohol, for histological purposes 85-95% alcohol.

Strickland (Biol. Bull., XXI, 1911, 306), has recommended Kahle's fluid (30 parts water, 15 parts 96% alcohol, 6 parts 40% formalin, 1 part glacial acetic acid) as superior to Gilson's mixture for fixing larvæ of Simulium and it may perhaps be superior for Odonata.

Schulze (Deut. ent. Zeitschr., 204, 1915) suggests a mixture of 200 cc. glycerine, 200 cc. distilled water and 1 gram crystallized carbolic acid for preservation of larvæ for dissection, especially in the tropics.

Further directions for preparation of histological material must be sought in such works as Bolles Lee's "Microscopists Vade Mecum," 7th edition, Philadelphia, Blakiston, 1913.

COLLECTING MANUALS.

For suggestions and directions on collecting and preserving dragonflies see:

1. Directions for collecting and rearing dragonflies, stone flies and May flies, by James G. Needham. Part O of Bulletin No. 39, U. S. Nat. Mus., 1899.

2. Directions for collecting and preserving insects, by Nathan Banks. Bulletin 67, U. S. Nat. Mus., 1909.

UNIVERSITY OF MICHIGAN.

MUSEUM OF ZOOLOGY.

Miscellaneous Publications No. 2.

An Annotated List of the Odonata of Indiana

BY

E. B. WILLIAMSON.

ANN ARBOR, MICHIGAN.

PUBLISHED BY THE UNIVERSITY.

JUNE 5, 1917.

ADVERTISEMENT.

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

CONTENTS.

PAGE

Introduction 5

List of Species 6

Bibliographical Notes 12

ILLUSTRATION

Outline Map of Indiana Showing Location of Counties .....Facing Page 12

AN ANNOTATED LIST OF THE ODONATA OF INDIANA.

BY E. B. WILLIAMSON.

Introduction.

Our knowledge of Indiana Odonata began in 1839 when Thomas Say recorded 17 species for the state. This seems hardly a good start since many an old gravel pit on a favorable day may yield a larger number of species. In Ohio, Hine and Osburn took 58 species during a week's collecting. But Say was not a specialist in the group, and in 1839 that great specialist, de Selys, had published only the third one of his many later papers, while Hagen in the same year made his first contribution to entomology. Burmeister and Rambur's books on Neuroptera appeared in 1839 and 1842. Say's odonate publication, too, it must not be forgotten, was the result of earlier studies and was published posthumously. Thus considering the time and circumstances together with the range of Say's activities, the start does not seem to be so poor. Following the publication of Say's paper there was a gap of 56 years before a paper dealing exclusively with Indiana dragonflies appeared, and it recorded only 14 species as against Say's 17. Indiana was too far west to be visited by the eastern entomologists and too far east to share in the great western explorations of the period.

The present list of dragonflies brings our knowledge of the distribution of these insects within the state up to date, and such references to the literature* are included as will enable students to identify species not described or not well described in my paper, "The Dragonflies of Indiana," Indiana Geological Report for 1899. References to this list will show that records for the southern half of the state are practically wanting. As a matter of fact the entire list is based largely on random field work, carried on as opportunity permitted and done almost entirely on Sundays and all too rare holidays. The records, both as regards dates and localities, are based in every case upon specimens examined except where the contrary is noted, and, as here published, are condensed from detailed data in my possession. For convenience each month is divided into thirds, 1-10, 11-20 and 21-30 or 31. Where no figures follow the month, the dragonfly under discussion has been taken in all three divisions of the month.

* These references are grouped at the end of the list. The numbers following the specific names in the list refer to corresponding numbers in the bibliography.

LIST OF SPECIES.

Suborder ZYGOPTERA.

Family AGRIONIDAE.

Subfamily Agrioninae.

Genus **Agrion** Fabricius.[2]

1. *Agrion aequabile* Say.—Lagrange, Lake, Noble, Putnam, St. Joseph, Wells and Whitley Counties. May 20-31; June; July; August 1-10.
2. *Agrion angustipenne* Selys.—Crawford County (Chas. Dury). May 20-31.
3. *Agrion maculatum* Beauvois.—Allen, Crawford, De Kalb, Elkhart, Fountain, Kosciusko, Lagrange, Lake, Noble, Putnam, Shelby, Steuben, Wells and Whitley Counties. May 11-31; June; July 1-20; August 11-20; September 1-10.

Genus **Hetaerina** Hagen.

4. *Hetaerina americana* Fabricius.—Allen, Blackford, Dearborn, De Kalb, Elkhart, Fountain, Franklin, Huntington, Kosciusko, Lagrange, Lake, Montgomery, Noble, Putnam, Shelby, Steuben, Wells, and Whitley Counties. May 20-31; June 11-30; July; August; September 1-10.
5. *Hetaerina titia* Drury.[3,4]—Franklin. Lagrange and Wells Counties. August 11-20; September 1-10.

Genus **Lestes** Leach.

6. *Lestes congener* Hagen.—Allen, Noble, Steuben and Wells Counties. August 11-31; September 1-20.
7. *Lestes disjunctus* Selys.—Allen, Elkhart, Kosciusko and Wells Counties. July 11-31.
8. *Lestes eurinus* Say.—Elkhart and Wells Counties. May 20-31; June; July 1-20.
9. *Lestes forcipatus* Rambur.—Allen, Blackford, Noble, Wells and Whitley Counties. April 20-30; May; June; July; August; September 1-10.
10. *Lestes inaequalis* Walsh.—Allen, Kosciusko, Steuben and Whitley Counties. June 10-20; July.
11. *Lestes rectangularis* Say.—Adams, Allen, Blackford, Elkhart, Kosciusko, Lagrange, Noble, Putnam, Steuben, Wells and Whitley Counties. May 20-31; June; July; August 1-10, 20-31; September 1-10.
12. *Lestes uncatus* Kirby.—Allen, Blackford, Noble, Steuben, Wells and Whitley Counties. May 20-31; June; July.
13. *Lestes unguiculatus* Hagen.—Allen, Blackford, Elkhart, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. May 21-31; June 1-10, 21-30; July; August 11-31; September 1-20.
14. *Lestes vigilax* Hagen.—Allen, Blackford, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. June 1-10. 21-30; July; August 11-31; September 1-10.

Subfamily Coenagrioninae.

Genus **Argia** Rambur.

15. *Argia apicalis* Say.—Allen, Blackford, Dearborn, Elkhart, Fountain, Kosciusko, Putnam, Shelby, Warren, Wells and Whitley Counties. June; July; August; September 1-10.
16. *Argia moesta* Hagen.[3]—Allen, Blackford, Crawford, Dearborn, Elkhart, Fountain, Kosciusko, Steuben, Wells and Whitley Counties. June; July; August 1-21; September 1-21.
17. *Argia sedula* Hagen.—Allen, Dearborn, Elkhart, Franklin, Jay, Kosciusko, Lagrange, Noble, Shelby, Steuben and Wells Counties. June; July; August; September.

18. *Argia tibialis* Rambur.—Adams, Allen, Blackford, Crawford, Dearborn, Kosciusko, Putnam and Wells Counties. May 21-31; June; July; August 1-10.
19. *Argia translata* Hagen.[4]—Shelby County. August 11-20.
20. *Argia violacea* Hagen.—Adams, Allen, Blackford, Crawford, Dearborn, DeKalb, Elkhart, Kosciusko, Lagrange, Marion, Noble, Steuben, Wells and Whitley Counties. June; July; August; September.

Genus **Enallagma** Charpentier.

21. *Enallagma antennatum* Say.—Allen, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. May 11-31; June; July; August.
22. *Enallagma aspersum* Hagen.—Kosciusko and Wells Counties. May 21-31; June 21-30.
23. *Enallagma calverti* Morse.[5]—Marshall, Noble and Wells Counties. May 21-31; June; July 1-10.
24. *Enallagma carunculatum* Morse.—Blackford, Elkhart, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. May 21-31; June 1-10, 21-30; July; August 11-20; September 1-20.
25. *Enallagma civile* Hagen.—Allen, Blackford, Elkhart, Grant, Wells and Whitley Counties. May 11-31; June; July; August; September 1-20.
26. *Enallagma cyathigerum* Charpentier.[6]—Noble and Wells Counties. May 21-31; June 11-20.
27. *Enallagma divagans* Selys.—Steuben and Whitley Counties. June 11-31; July 1-10.
28. *Enallagma ebrium* Hagen.—Allen, Blackford, Elkhart, Lagrange, Noble, Steuben and Wells Counties. May 21-31; June; July 1-20.
29. *Enallagma exsulans* Hagen.—Allen, Dearborn, Elkhart, Fountain, Kosciusko, Marion, Noble, Putnam, Shelby, Steuben, Wells and Whitley Counties. May 21-31; June; July; August.
30. *Enallagma geminatum* Kellicott.—Allen, Blackford, Elkhart, Fountain, Kosciusko, Steuben, Wells and Whitley Counties. May 21-31; June; July 1-20; August 1-20; September 1-20.
31. *Enallagma hageni* Walsh.—Allen, Blackford, Crawford, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July.
32. *Enallagma piscinarium* Williamson.—Wells County. July 1-10.
33. *Enallagma pollutum* Hagen.—Allen, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. June; July; August 11-20; September 1-10.
34. *Enallagma signatum* Hagen.—Allen, Blackford, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July; August 1-20; September 1-20; October 1-10.
35. *Enallagma traviatum* Selys.—Allen, Kosciusko, Steuben, Wells and Whitley Counties. June; July 1-20.

Genus **Nehalennia** Selys.

36. *Nehalennia gracilis* Morse.[7]—Lagrange County. July 1-10.
37. *Nehalennia irene* Hagen.—Allen, Elkhart, Fountain, Kosciusko, Lagrange, Marshall, Noble, Steuben, Wells and Whitley Counties. May 11-31; June 11-30; July; August 11-21.

Genus **Amphiagrion** Selys.

38. *Amphiagrion saucium* Burmeister.—Allen, Elkhart, Huntington, Lagrange, St. Joseph and Steuben Counties. May 21-31; June; July 1-10, 21-31.

Genus **Chromagrion** Needham.[8]

39. *Chromagrion conditum* Hagen.—Allen and Steuben Counties. May 21-31; June 11-20; July 1-10.

Genus **Ischnura** Charpentier.

40. *Ischnura kellicotti* Williamson.—Steuben and Whitley Counties. June 1-10, 21-30; July; August 11-31; September 1-10

41. *Ischnura posita* Hagen.[9]—Allen, De Kalb, Elkhart, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. May; June; July; August; September 1-20.
42. *Ischnura prognata* Hagen.[10]—Wells County. April 21-30; June 21-30.
43. *Ischnura verticalis* Say.—Allen, Blackford, Crawford, De Kalb, Elkhart, Fountain, Kosciusko, Lagrange, Marshall, Noble, Steuben, Wells and Whitley Counties. May; June; July; August 1-20; September 1-20.

Genus **Anomalagrion** Selys.

44. *Anomalagrion hastatum* Say.—Blackford, Elkhart and Wells Counties. May 1-10; June 21-30; July.

Suborder ANISOPTERA.

Family AESHNIDAE.

Subfamily Petalurinae.

Genus **Tachopteryx** Selys.

45. *Tachopteryx thoreyi* Hagen.—Montgomery County (C. C. Deam). July 21-31.

Subfamily Cordulegasterinae.

Genus **Cordulegaster** Leach.

46. *Cordulegaster diastatops* Selys.[11]—St. Joseph County. May 21-31.
47. *Cordulegaster maculatus* Selys.[12]—Noble County. June 1-10.
48. *Cordulegaster obliquus* Say.—"Inhabits Indiana" (Say).

Subfamily Gomphinae.

Genus **Progomphus** Selys.

49. *Progomphus obscurus* Rambur.—Allen, Dearborn, Elkhart, Huntington, Kosciusko, Putnam, Steuben, Wells and Whitley Counties. June; July.

Genus **Hagenius** Selys.

50. *Hagenius brevistylus* Selys.—Allen, Elkhart, Kosciusko, Noble, Putnam, Shelby and Wells Counties. June; July 1-10; August 11-31; September 1-10.

Genus **Ophiogomphus** Selys.

51. *Ophiogomphus rupinsulensis* Walsh.—Allen, Elkhart, Kosciusko and Wells Counties.—May 1-10, 21-31; June.

Genus **Erpetogomphus** Selys.

52. *Erpetogomphus designatus* Hagen.[13]—Dearborn and Franklin Counties. July 21-31; August 21-31.

Genus **Gomphus** Leach.

53. *Gomphus crassus* Hagen.[14]—Wabash and Wells Counties. May 11-31; June 1-20; July 11-31.
54. *Gomphus dilatatus* Rambur.—Crawford and Kosciusko Counties. May 21-31; June 21-31.
55. *Gomphus exilis* Selys.—Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July 1-20.
56. *Gomphus fraternus* Say.—Allen, Blackford, Dearborn, De Kalb, Elkhart, Huntington, Noble, Putnam, St. Joseph, Wabash, Wells and Whitley Counties. May 11-31; June; July 1-20.
57. *Gomphus furcifer* Hagen.—Allen and Lake Counties. June 1-20.
58. *Gomphus graslinellus* Walsh.—Adams, Blackford, Huntington, Marshall, Putnam, Wabash, Wells and Whitley Counties. May 11-31; June; July.

59. *Gomphus lividus* Selys.[15]—Allen, Elkhart, Lagrange, Noble, Steuben and Wells Counties. May 21-31; June 1-20; July 1-10.
60. *Gomphus quadricolor* Walsh.—Allen, Elkhart and Putnam Counties. May 21-31; June 11-30.
61. *Gomphus spicatus* Hagen.—Allen, Elkhart, Noble, Steuben and Whitley Counties. May 11-31; June 1-20; July 1-10.
62. *Gomphus spiniceps* Walsh.[18]—Allen and Wells Counties. July 11-20; August 1-10.
63. *Gomphus submedianus* Williamson.[16]—Elkhart County. May 21-31; June 1-10.
64. *Gomphus vastus* Walsh.—Elkhart, Putnam and St. Joseph Counties. May 11-31; June 21-31.
65. *Gomphus ventricosus* Walsh.—Allen, Lagrange and St. Joseph Counties. May 21-31; June 11-20; July 1-10.
66. *Gomphus villosipes* Selys.—Allen, Kosciusko, Putnam and Wells Counties. May 21-31; June 11-30; July 1-10.
67. *Gomphus williamsoni* Muttkowski.[17]—Wells County. June 1-10.

Genus **Dromogomphus** Selys.

68. *Dromogomphus spinosus* Selys.—Allen, Elkhart, Kosciusko, Putnam, Steuben, Wells and Whitley Counties. May 21-31; June; July 1-20; August 1-10.
69. *Dromogomphus spoliatus* Hagen.—Allen and Wells Counties. July; August; September 11-20.

Subfamily Aeshninae.

Genus **Boyeria** MacLachlan.

70. *Boyeria vinosa* Say.—Allen, Delaware, Elkhart, Kosciusko, Lagrange, Noble, Putnam, Steuben and Wells Counties. June 11-30; July 11-20; August 1-10, 21-31; September 1-10.

Genus **Basiaeschna** Selys.

71. *Basiaeschna janata* Say.—Allen, Elkhart, Kosciusko, Noble, St. Joseph, Wells and Whitley Counties. April 21-31; May; June.

Genus **Anax** Leach.

72. *Anax junius* Drury.—Allen, Blackford, De Kalb, Elkhart, Fountain, Kosciusko, Marshall, Noble, Steuben, Wells and Whitley Counties. April 21-31; May; June; July; August; September 1-20; October 1-10.

Genus **Aeshna** Fabricius.[19]

73. *Aeshna canadensis* Walker.[19]—Steuben County. August 11-31.
74. *Aeshna clepsydra* Say.—Steuben and Whitley Counties.. August 11-31; September 1-10.
75. *Aeshna constricta* Say.—Allen, Grant, Lagrange, Steuben and Wells Counties. August 11-31; September; October 1-10.
76. *Aeshna mutata* Hagen.[19]—Lagrange, Noble, Steuben and Wells Counties. June; July 1-20.
77. *Aeshna tuberculifera* Walker.[19]—Lagrange County (C. C. Deam). August 11-20.
78. *Aeshna umbrosa* Walker.[19]—Allen, Grant, Lagrange, Steuben and Wells Counties. July 11-20; August 11-31; September 1-20.
79. *Aeshna verticalis* Hagen.—Allen, Steuben and Wells Counties. August 21-31; September 1-20.

Genus **Nasiaeschna** Selys.[20]

80. *Nasiaeschna pentacantha* Rambur.[21]—Allen, Elkhart, Wells and Whitley Counties. June 1-20; July 1-20.

Genus **Epiaeschna** Hagen.

81. *Epiaeschna heros* Fabricius.—Allen, Elkhart and Wells Counties. March 21-31; April 11-30; May 1-10, 21-31; June; July 1-20; August 21-31; September 11-20.

Family LIBELLULIDAE.

Subfamily Cordulinae.

Genus **Didymops** Rambur.

82. *Didymops transversa* Say.—Allen, Elkhart, Noble, Steuben, Wells and Whitley Counties. May 11-31; June 1-20.

Genus **Macromia** Rambur.[22]

83. *Macromia illinoiensis* Walsh.—Allen, Elkhart, Kosciusko, Putnam, and Wells Counties. May 21-31; June 11-30; July; August 11-20.
84. *Macromia pacifica* Hagen.—Huntington and Wells Counties. June 11-30; July; August.
85. *Macromia taeniolata* Rambur.—Allen, Elkhart, Noble and Wells Counties. May 21-31; June 11-20; July 11-20; August 1-20.
86. *Macromia wabashensis* Williamson.[22]—Wells County. June 11-30; July; August.

Genus **Epicordulia** Selys.

87. *Epicordulia princeps* Hagen.—Allen, Elkhart, Kosciusko, Noble, Wells and Whitley Counties. May 21-31; June; July; August 1-20.

Genus **Neurocordulia** Selys.

88. *Neurocordulia obsoleta* Say.—"Inhabits Indiana" (Say).

Genus **Tetragoneuria** Hagen.[23]

89. *Tetragoneuria cynosura* Say.—Allen, St. Joseph, Wells and Whitley Counties. May 21-31; June.
90. *Tetragoneuria simulans* Muttkowski.[23]—Allen, De Kalb, Noble, St. Joseph, Steuben, Wells and Whitley Counties. May 21-31; June.
91. *Tetragoneuria spinigera* Selys.—Steuben County (Mr. and Mrs. C. C. Deam). June 11-20.

Genus **Dorocordulia** Needham.[24]

92. *Dorocordulia libera* Selys.[25]—Allen and St. Joseph Counties. May 21-31; June 11-20.

Genus **Somatochlora** Selys.

93. *Somatochlora charadraea* Williamson.[26]—Wells County. July 1-10.
94. *Somatochlora linearis* Hagen.—Fountain and Wells Counties. June 1-10; July 1-10.
95. *Somatochlora tenebrosa* Say.—"Inhabits Indiana" (Say).

Subfamily Libellulinae.

Genus **Libellula** Linne.

96. *Libellula cyanea* Fabricius.—Allen, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July; August 11-20.
97. *Libellula exusta* Say.—Elkhart, Lake and Wells Counties. May; June 1-10; September 1-10.
98. *Libellula incesta* Hagen.—Allen, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. June; July; August; September 1-10.
99. *Libellula luctuosa* Burmeister.[27]—Allen, Blackford, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July; August 1-20; September 1-10.
100. *Libellula pulchella* Drury.—Allen, Blackford, Crawford, De Kalb, Elkhart, Huntington, Kosciusko, Marion, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July; August 1-20.
101. *Libellula quadrimaculata* Linne.—Blackford, Elkhart and Wells Counties. May 21-31; July 11-20; September 21-31.

102. *Libellula semifasciata* Burmeister.—Blackford, Elkhart, Kosciusko, Steuben and Wells Counties. April 21-31; May; June 1-20; July 1-20.
103. *Libellula vibrans* Fabricius.—Blackford, Lake and Wells Counties. June; July 1-10.

Genus **Plathemis** Hagen.

104. *Plathemis lydia* Drury.—Allen, Blackford, Crawford, Elkhart, Kosciusko, Marshall, Wells and Whitley Counties. May 11-31; June; July 1-10, 21-31; August 11-31; September 21-31.

Genus **Perithemis** Hagen.

105. *Perithemis tenera* Say.[28]—Allen, Blackford, Elkhart, Jay, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July; August 1-10; September 1-10.

Genus **Nannothemis** Brauer.

106. *Nannothemis bella* Uhler.—Elkhart and Lagrange Counties. June 11-30; July 1-10.

Genus **Erythemis** Hagen.[29]

107. *Erythemis simplicicollis* Say.—Allen, Blackford, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July 1-20; August 1-10.

Genus **Sympetrum** Newman.

108. *Sympetrum ambiguum* Rambur.[30]—Blackford and Wells Counties. June 21-30; August; September 1-20.
109. *Sympetrum corruptum* Hagen.—Kosciusko and Wells Counties. July 11-31; August 1-10.
110. *Sympetrum decisum* Hagen.[31]—Wells County. September 21-30.
111. *Sympetrum obtrusum* Hagen.—Allen, Blackford, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. May 21-31; June; July; August; September; October 1-10.
112. *Sympetrum rubicundulum* Say.—Allen, Blackford, Elkhart, Huntington, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. June 11-20; July; August 11-31; September 1-20.
113. *Sympetrum semicinctum* Say.—Huntington, Lagrange and Whitley Counties. July 1-10, 21-31; September 1-10.
114. *Sympetrum vicinum* Hagen.—Allen, Elkhart, Grant, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. June 21-30; July 11-31; August; September; October 1-10; November 1-10, 21-30.

Genus **Pachydiplax** Brauer.

115. *Pachydiplax longipennis* Burmeister.—Adams, Allen, Blackford, Elkhart, Kosciusko, Noble, Steuben, Wells and Whitley Counties. April 21-30; May; June; July; August 1-20; September 1-10.

Genus **Leucorhinia** Brittinger.

116. *Leucorhinia frigida* Hagen.[32]—St. Joseph, Steuben and Wells Counties. May 21-31; July 1-10.
117. *Leucorhinia intacta* Hagen.—Allen, Blackford, Elkhart, Marshall, Noble, St. Joseph, Steuben, Wells and Whitley Counties. May 11-31; June; July.

Genus **Celithemis** Hagen.

118. *Celithemis elisa* Hagen.—Allen, Blackford, Elkhart, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. April 21-31; May 21-31; June; July; August; September 1-10.
119. *Celithemis eponina* Drury.—Allen, Elkhart, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. June 11-30; July; August 1-20; September 1-10.
120. *Celithemis monomelaena* Williamson.[33]—Allen, Kosciusko, Lagrange, Noble, Steuben, Wells and Whitley Counties. June 11-31; July; August 1-20.

Genus **Pantala** Hagen.

121. *Pantala flavescens* Fabricius.—Lake and Wells Counties. June 1-10; August 11-20.
122. *Pantala hymenaea* Say.—"Inhabits Indiana" (Say). Wells County. July 11-20; August 1-10.

Genus **Tramea** Hagen.

123. *Tramea carolina* Linne.—Blackford and Wells Counties. April 21-31; May.
124. *Tramea lacerata* Hagen.—Adams, Allen, Blackford, Kosciusko, Lake, Marshall, Noble, Wells and Whitley Counties. April 21-31; May 11-31; June; July; August 11-20; September 1-10, 21-30.
125. *Tramea onusta* Hagen.—Wells County. July 1-10.

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7. Psyche, 7, 1895, A. P. Morse, p. 274.
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12. See 6, p. 115.
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22. Proc. U. S. Nat. Mus., 37, 1909, E. B Williamson, pp. 368-398.
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27. As *L. basalis* in Drf. of Ind.
28. As *P. domitia* in Drf. of Ind.
29. As *Mesothemis* in Drf. of Ind.; see 1, p. 155.
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* This list is in no sense complete, and is designed merely as an aid to students of Indiana dragonflies. For a fuller bibliography see 1 above, and the American entomological journals, especially the Canadian Entomologist and the Entomological News, since 1910.

MAP OF INDIANA SHOWING LOCATION OF COUNTIES.

UNIVERSITY OF MICHIGAN

MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 3

A Collecting Trip to Colombia, South America

BY

E. B. WILLIAMSON

ANN ARBOR, MICHIGAN

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ALEXANDER G. RUTHVEN,
Director of the Museum of Zoology,
University of Michigan

CONTENTS

PAGE

Introduction 5

Itinerary 6

Cost of Trip 21

Notes on Equipment and Collecting Methods 21

Extra Equipment 21

Medicines 21

Collecting Methods 22

Common Names of Dragonflies 23

Acknowledgements 24

A COLLECTING TRIP TO COLOMBIA, SOUTH AMERICA

BY E. B. WILLIAMSON

INTRODUCTION

This trip to Colombia was made in the winter of 1916-1917 for the purpose of collecting dragonflies. The expenses were met by the Museum of Zoology and by the members of the collecting party, Jesse H. and E. B. Williamson, and the expedition will be known as the University of Michigan-Williamson Expedition. Dragonfly collecting had been done in Central America and in British Guiana by E. B. Williamson, and Colombia was selected for the present trip as offering a readily accessible, intermediate and relatively desirable region. Enthusiastic accounts of Dr. Eigenmann and Dr. Ruthven increased the writer's interest in the possibilities of Colombia as a collecting ground for dragonflies.

The time of year chosen for our trip was largely determined by information furnished us by Mr. M. A. Carriker, Jr., the well known bird student and collector, whose long residence in Colombia enabled him to give us accurately the data which we needed. This referred primarily to Santa Marta, which we had selected as our landing place, and to the adjacent country. At Santa Marta there are only two seasons, a dry season from December to March, inclusive, and a rainy season from April to November, inclusive. The first four months of the rainy season, April to July, inclusive, are bright and showery. September, October and November are cloudy and misty. The maximum drought is in February and March. The highest water stage in rivers is reached in September to November, and the lowest in March and April. Most birds nest in May, June and July, and most plants flower in April, May and December. These conditions prevail more or less up the Magdalena River to Honda, but in the interior there are two rainy and two dry seasons, the two dry seasons being December to February, inclusive, and June to August, inclusive. Other months are more or less rainy. In some localities rains may occur at any time throughout the year but especially in October. These Colombian seasons do not correspond with the seasons at Georgetown, British Guiana, where Mr. Rodway gave the writer the following data: short rainy season, November 15-February 15; short dry season, February 15-May 15; long rainy reason, May 15-August 15; long dry season, August 15-November 15. From other sources it was learned that in British Guiana most birds nest in May and June; showers may begin in April; highwater stage is reached June 30-July 15; October and November are low water stages; September is one of the most pleasant months, and the short rainy season of November 15-February 15 is the most disagreeable time of the year, being misty or drizzly.

With Mr. Carriker's data before us, we should have selected February or March to May or June as the most favorable four months for our work, but as other engagements prevented this we selected December-March as the best months at our disposal.

In selecting a time or season for zoological collecting in the tropics one must of course take into consideration other factors than those of rain-fall. The most essential of these factors are the group or groups of animals especially sought, and the elevation at which collecting is contemplated. In my case, experience in tropical collecting covers only the first six months of the year and regions north of the equator. Without presuming to generalize from such limited experience, I believe that insect collecting generally will prove profitable throughout the dry season in well watered lowlands up to an elevation of five hundred and possibly in some cases one thousand meters; that high elevations tend during the dry season to become progressively less productive as the elevation increases and as the season becomes drier; that the most quiescent state of tropical animal life is attained as the end of the dry season (April to June) is reached, and that at this time many rarer lowland species which are to be found at no other season appear or attain their maturity; and that the appearance of similar rarer species in the higher altitudes awaits the showery rains (April to June) which rejuvenate the fauna of both the high mountain valleys and the lowland swamps with the sudden appearance of many species, often in great numbers.

ITINERARY

Jesse H. Williamson left Seattle, Washington, in October. I left my home at Bluffton, Indiana, in November, and we met at Panama December 5. On December 6 and 7 Charles T. Tribolet and I collected at two small streams in the Canal Zone. Several stream species were teneral; of Perilestes and *Psaironeura remissa* only tenerals were seen; *Coryphaeschna adnexa* was pairing and ovipositing at a small back-water pool along the railroad track. On December 7 it began raining before noon and rained hard the balance of the day. December 8 was also rainy and no collecting was attempted. The two days, December 6 and 7, mark the beginning and end of Mr. Tribolet's career as a dragonfly hunter. While in the Canal Zone, we were hospitably entertained at the home of Mr. and Mrs. Raymond Shady, former residents of Wells County, Indiana.

Enroute from Colon to Santa Marta, we collected about Puerto Colombia, Colombia, on December 10 and 11. The country was very dry and sandy, and back for three or four miles we found no running streams, only small pools in creek beds. The so-called Arroyo Grande is a muddy, brackish backwater at this season. Some of the coastal dragonflies which congregate in great soaring flocks were abundant here. These flocks, usually rather loosely organized, may consist of as many as six species, and hundreds or thousands of individuals may be in view at one time.

We landed at Santa Marta December 12. The surrounding hills are dry and support a scanty vegetation at this season, cacti producing most of

the green color. The hospitality of the United Fruit Company was extended to us through the kindness of the local manager, Mr. Sinners, and we made the bachelor apartments our headquarters while at Santa Marta. December 13 to 19 were spent collecting in the vicinity, one day being spent with Mr. James Ryan on a gasoline motor locating favorable points along the railroad between Santa Marta and Aracataca. The railroad is in operation from Santa Marta to Fundacion, a few miles beyond Aracataca. There is a distinct change from the semi-arid conditions about Santa Marta to a more humid condition about Aracataca and Fundacion. Near the residential property of the United Fruit Company in Santa Marta is the Manzanares River, which about a mile above here has a left affluent, the Tamacal. These streams can also be reached by following the railroad track. Along the railroad track, before reaching the Manzanares, there were some good pools, and just beyond the bridge over the Manzanares was a pond, on the upper side of the track, of possibly two or three acres. At the lower end of this pond were large areas of a three-parted leaved plant which, in habit, much resembled spatterdock, and near the upper end were areas of cat-tails. Following the railroad track beyond the Manzanares we came to a low forest of large trees with many small muddy streams, and, near the farther edge of this forest, to the Tamacal River.

The gullies leading back from the Manzanares and Tamacal were dry. Near the coast were extensive shallow salt marshes, known as salinas, where Ischnuras abounded and where the coastal libellulines flew by thousands. The days at Santa Marta were sunshiny, rarely hazy, with but one afternoon's rain. It was generally windy and at night blew so hard that we had to close the doors and windows in order to paper our dragonflies. We spent one day on the Rio Donjaca, a small, clear rocky stream ten to fifteen feet wide about twenty-five kilometers from Santa Marta. We found little of interest here, and walked back to a small sandy stream between kilometers 17 and 18. This also we found disappointing. The seven days about Santa Marta yielded 60 species of dragonflies and 1,208 specimens.

Bolivar, located about five miles out of Santa Marta, was a residence of Mr. O. L. Flye, general manager of the Cincinnati Coffee Company. Through the hospitality of Mr. Flye and his secretary, Mr. Robert Sargent, we were entertained there from December 20 to 26. The road from Santa Marta to Bolivar had been extended beyond Bolivar five miles to La Tigrera, following the Tamacal most of the way. Along the Tamacal and its few tributaries were medium growth forests; the hills were covered with grasses except where thickets or rank herbaceous growths predominated. Ipomoeas or related plants were not so conspicuous as they were about Santa Marta and along the railroad, where they frequently formed beautiful curtains of bloom. About Bolivar the country was largely pasture land of guinea grass with extensive areas of native xerophytic plants. The altitude of Bolivar is probably about fifteen metres, that of La Tigrera about ninety-one metres.

The Tamacal and its few permanent tributaries between Bolivar and La Tigrera were clear, rapid and rocky, and for the most part in shade.

West and north of the house at Bolivar on the east side of the road from Mamatoca to Lavilla and south of Mamatoca was a large and varied swamp. It was in both sun and shade and contained rank growths of bushes, sedges, cat-tails, ferns often ten feet high, duck-weed, the spatter-dock-like plant seen at ponds near Santa Marta, and a common thick-leaved, floating rosette plant in which *Coryphaeschna virens* usually oviposited. Here dragonflies were very numerous. Smaller pools occurred elsewhere in bush, mostly a small spiny palm, but they were less varied and few dragonflies were found about them. Along the Bolivar-La Tigrera road and in sheltered sunny nooks Macrothemis flew in great numbers, and at sunset Gynacanthas in limited numbers came out of the brush to patrol the edges of the road. Where this road crosses the Tamacal on a plank bridge one can leave the wagon road and follow the old mule trail from that point to the house at Bolivar. We found this trail shadier and more interesting than the main road, and usually followed it in our tramps up and down the Tamacal. About four miles from Bolivar, on the road to La Tigrera, an obscure foot path crossed the Tamacal and passed back through the brush and over the hills to a small banana planting. A beautiful little stream, a tributary of the Tamacal, flowed past this planting. On low vegetation in sunny spots in this field we took about twenty-five specimens of a small Progomphus found nowhere else on the trip. Our work about Bolivar brought our collection up to 70 species and 2,257 specimens.

On December 27, we went by mule from Bolivar to Cincinnati, where, through the kindness of Mr. Flye, we were received as guests in his home. Cincinnati is situated at an elevation of 1,371 metres. The distance by mule trail from the end of the wagon road at La Tigrera to Cincinnati was ten miles. Above La Tigrera the mountains were for the most part wooded with only occasional clearings. Near the many permanent streams tree and climbing ferns were numerous and conspicuous, and on many of the banks were great expanses of flowering begonias. Coffee was being picked at the time of our visit, and the many flowering Compositae gave one the impression of autumn at home. We collected for five days about Cincinnati, assisted at times by William Flye and W. L. Laux. Collections were made along various streams from an elevation of 762 metres to 1,371 metres, the lower elevations proving more productive. About Cincinnati we found for the first time the peculiar dragonfly Allopodagrion, one of the coenagrionines, which nevertheless rests on leaves, stones, logs or sand with wings as flatly spread as any gomphine. Here also we took at the smallest streams a beautiful and erratic Aeshna, seen nowhere else. While there was no rain during our stay at Cincinnati, great masses of clouds frequently obscured the sun, often for long intervals, and at such times odonate life simply disappeared and did not immediately reappear with the sunshine. Moreover the deep canyons in which the streams flowed served to keep them shaded except where some were exposed to the sun a few hours during the middle of the day. Under such conditions all dragonflies became exceedingly wary and sensitive to the slightest movements, and, by rising among the trees to lofty perches far out of reach, sought to escape in the very direction in which

pursuit was impossible. Even the usually rather stolid Argias showed this wariness. One day at Agua Dulce, at an elevation of about 762 metres, we took seven species of this genus. No Gynacanthas were seen about Cincinnati though they were sought in several likely places.

Below the coffee mill we found a peculiar small catfish which climbed waterfalls by clinging to the vertical rocks by means of spines on the under side of the head, and by making occasional flips upward of an inch or less at a time. At rest it looked like a whisp of algae or a bit of rag attached to the rock face and washing about in the falling water.

We left Cincinnati January 2 with our collection totalling 80 species and 2,916 specimens. That evening we looked without success for Gynacanthas near the pools and in the woods up the railroad above Santa Marta. The Manzanares was carrying more water than when we saw it in December. January 3 was spent along the Tamacal, now scarcely occupying its flat bed of fine sand, the stream being only six to ten feet wide. Our total collection to date was 81 species and 3,196 specimens.

On January 4 we went to Rio Frio. We selected this place because of the fine stream, forty to sixty feet wide,—the Rio Frio,—the close proximity of the hills, and the accommodations kindly offered us by the United Fruit Company through the Rio Frio manager, Mr. Pepin. About this place there were extensive banana fields. Where not irrigated the soil was dry and sandy and the vegetation stunted. A stream six to ten feet wide with a good flow of water in the hills was found to disappear when it came out on the flat sandy country. Many other streams were diverted for irrigation, and the flow of the Rio Frio was largely used for the same purpose. There were a number of small marshes in the neighborhood. Weather conditions were good during our stay at Rio Frio. It was usually cloudy in the early morning and again about four p. m. In the afternoon we frequently encountered flocks of Macrothemis which numbered thousands of individuals. They were mostly of one species, the females greatly predominating, the males very rare, and mature adults of either sex being still rarer or wanting. The only interest of the individuals of these flocks was the catching and eating of small insects, and their life at this time was a rather definite transitional stage between the larva and the sexually mature insect.

When we left Rio Frio on the morning of January 9 our collection totalled 94 species and 4,135 specimens. Enroute to Fundacion we collected an hour or two about some small marshes and along irrigating ditches at Aracataca. Up to this time the only Neoneura taken had been *Neoneura esthera,* but at Fundacion we found *Neoneura bilinearis* associated with *Neoneura esthera,* numbers of both species ovipositing in dead grassy debris caught in fences and similar obstructions in irrigating ditches. *Neoneura bilinearis* was so much paler than Brazilian and Guianan specimens, with the areas of green and yellow so much larger, that it was mistaken for a new species. Later along the Rio Cesar, the same species was seen ovipositing at the water's edge in the solid mud banks. Both species, *Neoneura esthera* and *Neoneura bilinearis,* were found together as far inland as Cristalina, near Puerto Berrio.

At three-thirty p. m. we arrived at Fundacion, the end of the railroad. Smaller areas were under cultivation here than at most towns along the railroad. Along the grade of the railroad Y at the west edge of the town were a few dirty shallow pools about which numbers of Gynacanthas flew in the evenings. West of this Y and visible from it was a large marsh situated in a great pasture field. This marsh was shallow and the open area did not exceed an acre. The principal vegetation was grass. Other plants which attracted attention were a conspicuous Juncus; a water-lily with crinkled margined leaves and white elevated flowers; a low growing, beautiful purple flower; and clumps of a large plant resembling a Heliconia, but with branched flower stalk and small purplish flowers. Over the low hills west of this marsh was a similar but smaller one. Here were growing another species of water-lily with entire leaves, and two large clumps of a giant Cyperus. Still farther west we encountered a series of long pools or lagoons, running in a northerly direction. One may reach these lagoons also by going west of town along the grade made for the extension of the railroad, this grade having been extended beyond the point where the lagoons are crossed. These lagoons represent an old river bed, probably that of the Rio Fundacion. Near where the railroad grade crosses them they were deep and treacherous and filled with floating grass and debris. Several times in collecting about them I found myself floundering in the water over my head. The adjacent country was semi-arid and brushy and was generally over-pastured by half-starved cattle. Trees on the immediate banks of the lagoons were literally filled with iguanas, which hunted about on the ground, and, when disturbed, ran for the trees, reminding us, strange as it may seem, of fox squirrels at home. The lagoons themselves were teeming with crocodiles, whose grunting sounded much like that of dogs.

From the southwest part of Fundacion a well worn trail led off through the woods in a southerly direction. A mile or less from town smaller trails led off from the main trail. These, as far as explored, led to small farms of sugar cane, yuca and bananas, or pastures cleared in the forest. The main trail one and a half or two miles out from town crossed a large, nearly dry creek or arroyo in which remained pools of varying lengths, eight to ten feet wide. This very muddy creek bed, followed down stream for about half a mile, brought us to the Rio Fundacion. Just before the main trail crossed the arroyo, a trail led off to the left. This itself immediately crossed the arroyo, and, after passing through a small growth wood and a pasture, came out on the bank of the Rio Fundacion above the mouth of the arroyo and then followed up the river. Where the path followed the river closely, we took a number of specimens of a most peculiar small gomphine. This gomphine was most common in a growth of Heliconias and mixed palm and bamboo forest, where the path passed between the river and a large lagoon into which the river flows during high waters. This lagoon was not discovered until our second visit. Doubtless many such lagoons are scattered through the forest, unknown and inaccessible because of the spiny and thorny jungle. The path ended in a small farm where a number of products were cultivated, and in the fields, resting on grass and low plants,

another gomphine was taken. Going back to the main trail and crossing the arroyo, we found another trail branching to the left. This trail passed through the wood and by some small clearings and plantings, including a small banana field on the left, to end at a shelter hut in a yuca and sugar cane field two or three miles from the main trail. Resting on twig tips in the wood along this trail a third gomphine was taken. This gomphine was usually found in moist locations where Heliconias of gigantic size grew in clumps and where the forest had a dense growth of dwarf bamboo one to two feet high. They also occurred, but in fewer numbers, wherever a fallen tree top furnished some dead twigs for perches. They were found in both sun and shade but preferred mixed or patchy sunlight.

East of town was an irrigating ditch. The trail on the south side of the cemetery led to it through brushy pastures. Just above the juncture of the ditch and the trail were some low woods densely carpeted with selaginellas and similar low plants. In this low vegetation and in adjacent brush, consisting of spiny palms, hooked bamboos, Heliconias and other mostly spiny plants, we found large numbers of Metaleptobasis. Most of these we caught by hand as we wriggled through the brush. Any other mode of progress was impossible, and an insect net was useless under such conditions.

The days at Fundacion were generally bright. One afternoon was cloudy; and it rained most of one night and till about ten a. m. the next day, remaining cloudy till noon. The great flocks of Macrothemis with which we had grown familiar about Santa Marta, Bolivar and Rio Frio, were absent here.

We left Fundacion the morning of January 15, the collection to date numbering 107 species and 4,945 specimens. We took a night ferry from Cienaga to Barranquilla which we reached about six-thirty a. m. January 16. We left Barranquilla on the river steamer Manizales after sundown January 18. The boat spent the early part of the night ramming first one bank and then the other, and tearing souvenirs from sundry boats and barges tied up in the canal leading from the city to the Magdalena River. We arrived at Calamar about sundown January 19. The night of January 20 we tied up at Yati where a lot of cattle were to be loaded on board next day. We took advantage of this delay and spent the forenoon of January 21 collecting up river to Magangue where our boat arrived about two p. m. The country about Yati and Magangue was fairly typical of a hundred miles or more of the country adjacent to the lower Magdalena. Great pastures succeeded one another, with frequent lagoons a short distance back from the river and paralleling it. Heavy forests were rare. The hills are far back from the river, frequently none being seen in a day's travel. Walking from Yati to Magangue the road followed closely along the river with extensive lagoons on the other hand, and passed over two small tributaries. We saw Brachymesia and Miathyria literally by thousands.

El Banco, 86 leagues up the river from Barranquilla, had been chosen as our first stop. We arrived there about five p. m., January 22, and made ourselves at home at the Central Hotel. Cattle raising was the principal

business at El Banco. For several hours before reaching the town we were passing, on the left bank of the river, the finest and most extensive pasture seen. El Banco is well situated on high ground at the juncture of the Rio Cesar with the Magdalena. Above El Banco was extensive fishing in the Cesar which was deep and swift with bare washed mud banks. The fish, taken in nets, were dried on racks or on the ground. We followed a wide road, the Camina Chimichague Y Chiriguana, leading out from El Banco, which at first passed through some slightly rolling country. The stream beds here were all dry, with the banks and immediately adjacent country wooded with bamboo and palms. About three miles from town two trails left this road. The trail to the right apparently followed the Rio Cesar; the other, to the left, was probably the Mompos road. These trails immediately crossed a perfectly flat, scantily grassed, sun-baked plain over which termite nests were scattered with sufficient regularity and with just sufficient variation in size to give the impression of an old and very large cemetery. That we were suffering from thirst and our heads fairly rocking with the heat when this funeral plain came into view, detracted nothing from the vividness of the impression. Both trails led to a scarcely perceptible depression, marked by adjoining forest which traversed the plain like a broad ribbon. The shallow creek bed in this forest was almost dry, but about the long stagnant pools *Psaironeura remissa* flew by hundreds. One of these pools was possibly one hundred yards long. All were shaded. Large numbers of small brown monkeys took considerable interest in our work and showed some offense at our presence.

About half a mile out from town, on the right hand side of the main road, are several marshes. We attempted to work these and then cut across in an easterly direction to the Rio Cesar, but were unable to do this because of low impenetrable jungle. The marshes themselves yielded but poor results.

For about two miles which we explored above El Banco the right bank of the Rio Cesar was largely pasture, the original forest having been almost entirely destroyed. At this point a large affluent from the right comes into the Rio Cesar. Like the Magdalena, the Cesar had lagoons, only on a smaller scale, and in some of these, which were stagnant and muddy and heavily shaded with brush, we took numbers of shade-frequenting coenagrionines. Sometimes we secured these where the dense gloom made it almost impossible for us to distinguish the insects. It is rather remarkable that the great forested areas of the north, at least of the Nearctic region, have no such shade-frequenting dragonflies as occur about both ponds and streams in the tropics. Possibly our more northern species are more ancient than the environment in which they now find themselves.

We left El Banco the afternoon of January 26, bound up river for Barranca Bermeja, 139¼ leagues above Barranquilla. Our collection now totalled 113 species and 5,407 specimens.

The days that followed differed but little from the days spent between Barranquilla and El Banco. At night the boat was tied up to the bank. During the day there were the same frequent stops to take on wood. The

food was good, sleeping on deck at night was pleasant, our traveling companions were friendly and agreeable, and the frequent delays cost us nothing as our tickets included meals. Consequently when a sand bar held us for a few hours or a smashed wheel delayed our progress for a day, the calmest philosophy could prevail, at least among the passengers. It would be possible for a collector interested in insects attracted by light to rig his outfit on the upper deck of one of the slower river steamers and to obtain thus on a round trip from Barranquilla to La Dorado, a distance of 198 leagues, a fair representation of the night-flying insects of the whole lower Magdalena. The time required would be about three weeks, and the round trip transportation, including meals, was, when we were there, $30 on one line of steamers and $60 on another; the service was about the same on both.

We approached Gamarra January 27. The country is flat with mountains in the distance. At Gamarra the hills seemed relatively near at hand, but we learned that Aguachica, about twelve miles from Gamarra on the road to Ocana, is in the river plain, and that Pie de la Cuesta, about twenty-four miles from Gamarra, on the same road, is in the hills. Though a small town, Pie de la Cuesta had ample accommodations for travellers. Ocana is about forty-two miles from Gamarra, a journey of a day and a half by saddle horse, costing, with a pack mule, $6 for the trip. It was our intention to go to Ocana on our return down the river but lack of time prevented this.

The topography above Gamarra is the same as that below the town. The country is flat with mountains in the distance. There were numerous sand bars in the river where we observed many crocodiles. As on preceding days small collections were made at several points where the boat tied up to take on wood.

During the afternoon of January 29 we reached Barranca Bermeja and put our baggage ashore. As no hills were in sight, and the country was very dry and unpromising with no small streams, we re-embarked and paid our fare to La Dorado, the end of lower river navigation.

Above El Banco the forests were larger, the bluffs more frequent, and the cienagas (lagoons) rarer. Below Puerto Berrio the Magdalena cuts through a bluff or ridge fifty to seventy-five feet high. January 30 about seven p. m. we arrived at Puerto Berrio, 163¾ leagues above Barranquilla. On both sides of the town are frequent low hills. Through the kindness of Mr. Lope M. Montoya G., of Medellin, to whom we are indebted for other data, we learned that the elevation of Puerto Berrio is about 130 meters.

Our boat was scheduled to leave Puerto Berrio January 31 at four p. m., so we decided to spend the day collecting and set out at seven-thirty a. m. About three and one-third kilometers from town a small sluggish stream, flowing north, crossed the railroad track. Near the track this stream was in a grass marsh condition, but it soon passed below into a dense overflow forest of tall trees, spiny palms and lower shrubs and vines, through which we could pick our way with slight difficulty. At this season the wood was moist but there was no standing water. The creek was from four to

ten feet in width and had a maximum depth of three feet and a generally firm mud bottom. Dragonflies were numerous in the varied habitats formed by forest, stream, sun and shade, and such diverse things as Perithemis and Metaleptobasis were found in numbers. This forest was rapidly being destroyed to furnish fuel for the railroad.

We were returning from our collecting about three p. m. and were near the Magdalena about a kilometer above town, when we heard a river boat chugging its way up stream. A hurried dash to the river's bank showed us our boat in midstream, carrying away, as we knew, all our baggage and supplies, while we stood in our wet clothes in a bamboo thicket on the river's bank and marked her passing. We yelled and waved our nets but attracted no attention. Fortunately J. W. thought of his revolver, and three shots attracted the attention of the captain, who most obligingly ran into shore and picked us up. From the other passengers, apparently as excited and delighted as ourselves, we learned that the boat had discharged its cargo, and, after whistling for us in vain for about an hour, had left Puerto Berrio between two and three p. m. This incident is related for two purposes,— to show the obliging friendliness of the captain in picking us up, and to record an instance in Latin-American affairs, when, for the only time known, events moved ahead of their schedule. The statement may be received incredulously by other travelers.

Twelve to sixteen leagues below La Dorado the forest was not quite so large as that below Puerto Berrio. The dirt banks were generally sloping, instead of vertical and caving as they usually were up to El Banco and some distance above it; and frequently the shores were rocky or gravelly instead of sandy as below. Both above and below Puerto Berrio were a few rock exposures. We arrived at La Dorado, 198 leagues above Barranquilla, on February 1. Contrary to what one might have expected from its commercial importance, La Dorado was a poor and insignificant town.

The character of the country along the railroad between La Dorado and Honda has changed greatly since Professor Bingham described it as a dense tropical jungle. We found it to be almost continuous pasture. There were two or three nice streams and some marshes within five miles of La Dorado, but from that point on to Honda the country was almost worthless to a dragonfly collector. We arrived at Honda about three p. m., February 2. Enroute we had made up our minds not to stop there, as we had originally planned to do. Observations and inquiries, which we made while the train lay over at Honda for nearly two hours, strengthened our decision and we entrained for Maraquita. There were small streams near kilometer post 37, between posts 38 and 39, and between posts 43 and 44. From about kilometer post 44 to Maraquita the country was a continuous flat pasture with high rocky hills in the background. At Maraquita we found a small satisfactory hotel, and Mr. A. G. Le Clercq, general manager of the railroad, to whom we carried a letter of introduction, gave us valuable assistance and advice in reaching desirable collecting grounds. The elevation at Maraquita is about 457 metres.

The San Juan River near Maraquita furnished the station and town

with its water supply. Near where the trail leading from town to the intake joined the river there was a large waterfall. Above this fall the San Juan was a fine rocky stream five to ten feet wide with rapid drop and with some high waterfalls. The sides of the valley through which it flows were high and rough and wooded with tall trees and bamboos, four to five inches in diameter, beneath which grew many Heliconias and some aquatic plants. Below the waterfall to its mouth in the Cuamo, it was a beautiful rapid stream six to fifteen feet wide, with some cliffs and generally high banks, but with no falls. The Cuamo carried about three or four times as much water as the San Juan, and, where we explored it for a short distance above the mouth of the San Juan, it was similar in character to the lower San Juan. It was one of the most beautiful rivers I have ever seen.

About three kilometers south of town the railroad crossed a very small stream which, when we were there, had almost ceased to flow. This we followed to its mouth in the Poquera. The Poquera was about five to fifteen feet wide and had a wide, relatively shallow, rocky and sandy bed. It is said to become nearly dry in the dry season.

As might be expected, species of Argia and Hetaerina were the conspicuous dragonflies where we collected about Maraquita. Along the upper San Juan we saw for the first time specimens of a new Thorine genus, Miocora, since described by Dr. Calvert from a Costa Rican male. Near the same place we took a female of an undescribed Erpetogomphus, a genus hitherto not known south of Costa Rica. On the same stretch of river we saw Heteragrions for the first time since leaving the Canal Zone, and Allopodagrion, previously taken at Cincinnati near Santa Marta, was common. Along the Poquera and its small tributary we found a small protoneurine, a much more inconspicuous insect than the notoriously inconspicuous *Psaironeura remissa*. Along the bank of the lower San Juan, near the water's edge, where a yellowish seepage formed a little swampy spot about one foot wide and six feet long, we took several specimens of a small Argia which was seen nowhere else. Damp places about the taps of the water pipes in the town were frequented during the day by the tropically omnipresent *Orthemis ferruginea* and after sundown by a few Gynacanthas. The weather at Maraquita was not the most favorable for collecting as generally it was very cloudy until about ten a. m.; and during the rest of the day the sun usually shone through a haze. A light rain fell during the night of February 5.

On February 6 we took train from Maraquita and returned to La Dorado. Our collection now numbered 126 species and 6,097 specimens.

Among the five river steamers tied up at La Dorado we found the General Cordoba, on which we had travelled from El Banco to La Dorado, and we at once engaged passage to Puerto Berrio. We left La Dorado about five a. m., February 7, and reached Puerto Berrio about ten a. m., February 8, having been delayed by a smashed wheel and stranded on a sand bar. The remaining hours of the day were spent along the same stream where we collected January 31. At some small grassy marshes along the railroad grade, enroute to this stream, we saw *Coryphaeschna virens*, a

Tramea, and several other typical tropical swamp species of wide distribution.

At six a. m., February 9, we took the train from Puerto Berrio to Cisneros. For about twenty miles the track ran through forest and fields and then began to climb into higher hills. Cisneros, the end of the railroad, at an elevation of 1,060 metres, was surrounded by country almost stripped of its forests, the remnants consisting of scattered clumps on the high hill tops. The Nus was yellow and dirty, due to the activities of gold diggers. The hotel at Cisneros was good but the devastation of the adjoining country made it an unfavorable collecting point. Sofia, near kilometer post 101, had a hotel, and was probably a much better collecting point than Cisneros.

The valley of the Rio Santa Getrudis opposite Cisneros, across the Nus, seemed to have more trees than usual in this region and we collected there February 10. The Rio Santa Getrudis was a clear stream ten to thirty feet wide, rapid throughout, and with many large waterfalls and rock masses. Had time permitted, we probably should have found the many small tributaries more productive than the main stream, but a little time spent on these was not encouraging. Along the main stream were only small clumps of forest, but the tree ferns, some thirty feet high, gave some hint of the glory that had been. From its mouth in the Nus we followed the stream up through the hills for several miles. Throughout this distance it was largely exposed to the sun, and the abandoned hill sides were covered with rank impenetrable grass and dewberry briars. Apparently the agricultural method in use consisted in clearing the forest, planting to crops, usually corn or sugar cane, until the soil was exhausted, abandoning it, and making another encroachment on the forest. The result was that the farmers lived far away from town, up the valleys of the numerous streams. The paths from the farms to town were conspicuous as yellow streaks on the devastated hills. The days collecting netted us only four dragonflies out of six seen, an almost unbelievably poor day. We needed no further evidence, and the next day, February 11, we took train back towards Puerto Berrio, leaving it at Cristalina, about twenty-eight kilometers above Puerto Berrio. Several good points were accessible along the railroad between Puerto Berrio and Cisneros. There was a good hotel at Puerto Berrio, and the train, leaving there early in the morning and returning in the evening, would have made it possible to collect over a wide variety of country with Puetro Berrio as headquarters. Cristalina was a little native village with no posada (inn), but we were able to rent a room in a hut from one family and to obtain board with another family, that of Lino Zapata, an intelligent native who acted as our mozo during our stay at Cristalina.

The elevation of Cristalina is about 320 metres. It lay in a densely wooded country abounding in beautiful small streams. Conditions were humid, vegetation was rank and small tree ferns were noted. A small stream, the Quebrada Cristalina, flowed directly through Cristaiina. The water of this stream was brought from the hills to the village and railroad through an iron pipe. During our first day at Cristalina, February 12, we followed this pipe back to the intake. Between the intake and the town the

stream flowed largely through pasture and brush land, but above the intake it flowed in forest. Here it was only one to three feet wide and was frequently lost in the stony gravelly bed. It had its origin in the hills about a mile above the intake. The richness and peculiarity of its dragonfly fauna may be realized from the fact that our first day's collecting yielded a Miocora, two species of Palaemnema, a Perilestes, three protoneurines, three Heteragrions, a Philogenia, an Allopodagrion, an Acanthagrion, a Megaloprepus, two Mecistogasters, and numbers of Argias, Hetaerinas, and libellulines. At a later date, collecting along the quebrada in the brush between the town and the forest we found two species of gomphines. Below town the railroad followed the Quebrada Cristalina more or less closely. About midway between kilometer posts 26 and 27 was a path to the left, past a single native hut in a field. This path brought us to the Rio Diez-y-ses, where it was bridged by a large log. Just above this foot bridge was the mouth of Quebrada Cristalina.

The Rio Diez-y-ses above the foot bridge was largely in forest. It was a fine stream fifteen to thirty feet wide, of varied character, with mud, sand, rocks, long pools and some rapids. Beyond the foot bridge over the Diez-y-ses was an abandoned railroad spur, running back at right angles to the stream. Following this spur to its end and taking the trail which skirted the forest, with brushy pasture on the right hand, we came to the Quebrada Sabaleticus, about three-fourths of a mile from the Diez-y-ses. This quebrada, in the forest, was a wonderfully fine stream six to twelve feet wide with frequent long pools and rapids. The firm footing, the beautiful and varied scenery, and the rich fauna made collecting here almost ideal. Here for the first time we saw Cora and observed its peculiar habit of ovipositing, which it shares with Miocora. The eggs are inserted in comparatively solid but barkless horizontal tree trunks or pieces of logs over water. In some cases the logs were scarcely damp, and the eggs were placed as high as six feet above the water. At least three species of gomphines lived along Sabaleticus, and no less than four Heteragrions.

Following the Sabaleticus up stream one and a half or two miles from where it emerges from the forest into the brushy pasture we came to a waterfall between four and five feet high—the highest waterfall we discovered on this quebrada. About a quarter of a mile above this waterfall a very small tributary from the right enters the quebrada. We followed this tributary to its source in the hills. About a half mile back from its mouth, standing at an angle of 60°-90°, is a broken rock face over which water dripped. Here and here only we found Mesagrion, hitherto known from a single male specimen, which, while closely related to Heteragrion, has the peculiar habit of resting with wings closed, and not half opened as one would expect from its relationships.

Below kilometer post 25 and on the left side of the railroad track was a cattle chute, from which a trail led to a clump of farm houses in a brushy pasture on the right bank of the Rio Diez-y-ses. A short distance below the cattle chute was a gate and another more distinct trail which brought us to the same destination. If we crossed the Rio Diez-y-ses at this point

and then kept to the right, following the cattle paths through the brushy pasture, we came to the Quebrada Camelia. By keeping to the left instead of to the right, we would come to the Quebrada Sabaleticus, but this route to the latter stream was longer than the one described above. The Quebrada Camelia is another beautiful little forest stream about twice as large as the Cristalina and two-thirds or three-fourths as large as the Sabaleticus. Here we took the fifth known specimen of Cyanogomphus, a new species, no two specimens of the same species being known.

These three quebradas are all tributaries of the Rio Diez-y-ses. Their locations have been described at some length because of the wonderful collecting conditions found about Cristalina. In the town and along the edges of the brushy pastures Gynacanthas flew in numbers after sundown. The edges of the forest where tree tops and logs lay in confusion were alive with a great variety of libellulines. In sunny nooks several species of Macrothemis hawked in numbers. Butterflies and beetles were numerous and varied, and many birds noticed nowhere else were seen here. The locality was readily accessible, being reached by train from Puerto Berrio, where all the river steamers from Barranquilla stopped. The people were kind and helpful in every way, and altogether this was the most ideal collecting locality I have found in the tropics. Expenses were at a minimum. Our room cost us about fifty cents a day. Arrangements could be made doubtless at half this price. Our food with the Zapata family was good, though unvaried, and cost fifty cents a day. We paid Lina one dollar a day for acting as mozo.

The weather conditions at Cristalina were not the best when we were there as the following brief notations for several consecutive days will show: February 12, sunshine most of the day; 13, cloudy most all day; 14, cloudy until noon, afternoon sunny; 15, cloudy all day, a few minutes rain in the afternoon; 16, forenoon cloudy threatening rain, afternoon cloudy with short intervals of sunshine, rained during the night; 17, forenoon fairly clear, afternoon mostly cloudy; 18, rained about six a. m. but the day was generally sunny; 19, a drizzling rain for fifteen to twenty minutes about eleven a. m., weather conditions unfavorable all day.

February 20 we returned to Puerto Berrio with our collection numbering 148 species and 7,993 specimens. The next day we collected once more in the wood near Puerto Berrio. Along a wood cutter's trail in the forest near the stream J. W. saw a red or reddish aeshnine (?) almost as large as a Staurophlebia.

February 22 we left Puerto Berrio on the steamer Ayapel and passed Barranca Bermeja about one p. m. Here great schools of fish were swimming up stream near the bank, forming a wide silvery ribbon in the water. Crocodiles were very numerous in the river. On February 23 we saw twenty-eight lying closely together on one sandbar and forty-six on another. A herd of cattle were in the water near the second group but the crocodiles and cattle paid no attention to each other. Our boat tied up for the night at a wood pile a short distance above El Banco, where we arrived about six-thirty a. m., February 24. We arrived at Magangue about five-thirty p. m.

and spent a pleasant hour with Mr. Carlos Nieto, a commission merchant with whom we had formed an acquaintance enroute up the river. That night our boat tied up at a cattle chute below Magangue. About daybreak they began loading seventy-five cattle on board, and, this accomplished, we reached Calamar about three p. m. We remained at Calamar until about two a. m., February 26, when we started for Barranquilla. The long delay we experienced in getting out of the canal leading to Barranquilla was repeated on our return. About eight a. m. the yacht Ideal, running as a ferry between Barranquilla and Cienaga, passed us in the canal, and, after prolonged shoutings and wavings on our part, returned, picked us up, and landed us at Cienaga about four p. m. We caught an extra mail train from Cienaga about seven p. m. and slept that night in our old rooms at the bachelors' quarters of the United Fruit Company at Santa Marta.

While ascending and descending the Rio Magdalena the objects probably most interesting both to the other passengers and ourselves were the large number of flowering trees in the forest. Other trees were also interesting but for other reasons. Frequently along the water's edge and just back from it were dense stands of small or moderately sized trees with very light colored trunks and branches and large leaves, known as the guarumo. Overtopping the forest, and sometimes standing out alone in beautiful majesty, were the bonga trees, at times with unbranched trunks rising one hundred feet, the perfect mushroom-shaped tops adding another fifty feet to their heights. The trunks exude a latex widely used by the natives in the treatment of boils. The wood is soft and useless. A number of flowering trees, as seen from the river steamer, seemed to rise to about the same height in the forest. One rare kind was a snowy white; another commoner kind was a bright dandelion yellow; another was blue; another dark blood red; and a very common and very beautiful one was a peach pink. There was little uniformity among the names given these trees by various passengers on the boats. A small broad tree which was very common had orange yellow flowers and orange brown buds in great profusion. Another common small tree had flowers in clusters, some of them red and some white or greenish. What we at first thought were the dull reddish bronze flowers of a tree, we found, on a closer view, to be the flowers of a vine which in some cases almost concealed the tree top over which it spread. Once at Maraquita we saw an ant trail where the petals of one of the pink trees were carried in a continuous narrow ribbon of color; a short distance away another ribbon of color, in this case bright yellow, moved slowly but uninterruptedly along.

It must be understood that the flowering trees mentioned above were not dominant in the forests along the Magdalena at the season we saw them. These forests were, like all lowland tropical forests we have seen, rather sombre masses of varying shades of green only rarely relieved by other and brighter colors. That enraptured vision which beholds tropical rivers flowing through ever-changing vistas of brilliant flowers of every conceivable hue has never been vouchsafed us. Neither have we been gifted with those supernatural powers of sight and hearing which some travellers possess and

which reveal to them in their voyages some of the rarest and most secluded animal denizens of the densest jungles. In fact nothing is more difficult to reconcile than the varying accounts of travelers in the tropics. For example, one celebrated author has reported a dense tropical jungle where we found broad pastures, and on the Magdalena he never saw a single crocodile where we observed thousands and where, by actual count, forty-six were seen on one small sandbar.

February 27 we collected in the low forest along the Tamacal and along the railroad about three miles out from Santa Marta. The leaves under the trees were very numerous and dry, but the trees were bright green, and more in flower than when we previously collected here. The ground was still moist under the leaves, and a small flow of water was still in the little streams in the wood. Dragonflies were rarer than formerly and no additional species were seen. The vegetation on the adjoining hills was quite brown and dead in appearance except for an occasional bush and numerous cacti. A yellow flowered prickly pear cactus was in bloom. The abundant, large, coarse, bushy, pink flowered Ipomoea (or related genus) was about done flowering and was becoming leafless, its seed pods bursting and revealing the hairy or woolly seeds. The flowering trees, which were numerous, had, so far as noticed, white blossoms. Fires were burning on the hills at some places. Coming down the Magdalena River we had seen many fires in the mountains. Our collection, including the specimens taken at the Canal Zone, Cartegena, Puerto Colombia and at various stops up the Magdalena River, not hitherto counted in the total, now numbered 150 species and 8,553 specimens.

The evening of February 27 we spent with Mr. and Mrs. Flye, Mr. and Mrs. Ryan, Robert Sargent and other friends; and the morning of February 28 about five o'clock we left Santa Marta on the United Fruit Company steamer of the same name bound for Colon.

We arrived at Colon March 1, and left there March 4. On March 5 we came at five p. m. to Bocas del Toro, Panama, and about six p. m. to Almirante. Here we looked without success for Gynacanthas.

March 6 was spent pleasantly with the English entomologist, Mr. C. B. Williams, who was studying the local frog-hoppers. We went on the railroad to Guabita and spent a few hours collecting there. Along the railroad from Almirante to Guabita there is some good collecting country, especially about twenty-three miles out from Almirante. Almirante would provide good headquarters for one wishing to work in southern Central America, as a varied country is accessible from here, and the expenses would be much less than in the Canal Zone.

The evening of March 6 we left Almirante, and arrived at Havana about ten a. m., March 10. We took a short country drive and at favorable looking streams searched in vain for Neoneuras. The boat sailed about four-thirty p. m. and reached New Orleans about six p. m. March 12, where we passed customs without friction or expense.

COST OF TRIP

Our expenses were about $650 each, but, as this included a number of unnecessary purchases, $600 may be considered a fair estimate of the cost. The round trip fare from New York or New Orleans to Santa Marta on the United Fruit Company steamers, including meals, was $180. Hotel rates at Santa Marta and Barranquilla were $2 a day; at El Banco the rate was $1.20 a day. The first class charge from Cienaga to Barranquilla was $3.50, with stateroom $1 extra. The round trip first class fare from Barranquilla to La Dorado without stateroom was $30 on one line of steamers and $60 on another line. On the first line the stateroom adds about forty per cent to the cost; on the second line about twenty per cent—that is, stateroom charges are about the same on both lines. We had staterooms from Barranquilla to El Banco, but at no time thereafter, as we really preferred sleeping on deck and the shower bath rooms sufficed for shaving and changing clothing. Sleeping on deck, however, requires retiring at a certain hour, when all the cots are brought out and distributed over the deck, and arising at a certain hour in order that the deck may be cleared for the day. Travelling on the river with frequent stopovers adds very little if any to the fare, as this is equitably figured on the basis of leagues between points. Mozos such as we employed for carrying our collecting outfits and lunches charged from sixty cents to one dollar a day. Carriages in cities for ourselves and several pieces of baggage cost us usually about $1 a trip.

NOTES ON EQUIPMENT AND COLLECTING METHODS

Extra Equipment.—At the hotels at Barranquilla one can arrange for the purchase of a mosquito net, a light blanket and a pillow for use on the river boats. We carried these necessary articles in an old burlap sack. Mr. Carriker recommended folding cots, but we were not able to purchase these in Barranquilla and were able to obtain only one cot at Cristalina. As a consequence during our stay there, J. W. slept on a narrow bench upholstered with old shirts and miscellaneous clothing. On the river steamers cots are furnished.

Medicines.—We made it a practice to take four grains of quinine a day in four doses. J. W. had no fever and I had only one light attack which put me in bed one day at Rio Frio, and from which I recovered after increasing the quinine for a few days to about fifteen grains a day. Amoebic dysentery was common along the river, and I had an attack at Maraquita, contracted probably at El Banco. No physics were taken but paregoric in frequent doses and alcresta ipecac were used from the start. Paregoric was discontinued when it was no longer needed, and ipecac, equivalent to 400 grains, was taken sixty grains a day. Recovery was rapid and I was incapacitated for field work only two or three days. For red bugs (harvest mites) we used the liquid known as cresol compound. This is known also by a great many trade names, and is sold everywhere as a disinfectant and for a dip or wash for live stock. It makes a milky mixture with water. We used it about

one part to ten parts of water, dipping a small rag in the mixture and moistening the entire body, morning and evening, and sometimes once during the night; in each case we allowed the fluid to dry on the body. It acts as a local anesthetic, and allays the irritation caused by the bites of other insects. It is also a splendid antiseptic. Its use enables one to collect where continuous field work would otherwise be impossible.

It may be remarked that the country about Santa Marta and more especially the country about El Banco have more than their share of biting and burrowing pests. At Bolivar excessive swelling of the hands, caused by insect bites, compelled J. W. to stay indoors a day or two. He counted one hundred and sixteen fresh bites on one arm one day. At El Banco we entertained red bugs by the thousands. Aqua ammonia was also useful in allaying the irritation caused by insect bites, and a scorpion sting J. W. received at Maraquita gave him little trouble when so treated. The prickles of a large leaved spiny plant, called ortiga or pringamosa, which were very irritating, invariably produced pustules in spite of all our remedies. Among so many spiny plants scratches and cuts result almost daily and in wading among logs and rocks one's shins are frequently barked. The wounds so caused were thoroughly cleansed and rubbed with a bit of gauze or cotton soaked in a solution of one hundred and twenty grains of resorcin and twenty grains of salicylic acid in eight ounces of fifty per cent alcohol. During the entire trip no wound became infected. Constant wading softens the feet and often the toes about the nails become sore and irritated. Iodine is the best treatment for this. It was found helpful to dust in our dry socks, after the day's collecting, a mixture of talcum powder, powered alum and sulphur. An attack of "dobie itch" was quickly cured with balsam of Peru after treating it without success with iodine and later with boracic acid.

Of course we carried the other paraphenalia usually found in first-aid outfits, but the above suggestions may prove useful to one planning his first collecting trip in the tropics. It should also be stated that salol is very valuable as an intestinal antiseptic; a missionary nurse told us she cured many cases of dysentery with it. J. W. had occasion to use it at one time and it gave almost immediate relief.

Collecting Methods.—The methods employed were essentially those which I have previously described.[1] However, a few additional suggestions may be made. In papering it is well to hold the envelope flat and leave the abdomen of the insect, especially of coenagrionines, a little above and parallel to the long fold in the envelope, and thus avoid pinching the specimen in the fold of the paper when the envelope is closed. At Cristalina our supply of smaller envelopes became exhausted, and it was necessary to paper several specimens in one envelope. This was accomplished by keeping the abdomens parallel and at right angles to the long fold in the envelope, arranging the insects so that the pressure of the envelope fell entirely on thoraces. The envelope was so placed in the drier that the abdomens hung

[1] "Directions for Collecting and Preserving Specimens of Dragonflies for Museum Purposes." Misc. Publ., Mus. of Zoology, Univ. of Mich., No. 1.

straight or extended parallel to the long fold. Of course careful handling of the envelopes was necessary until the insects were dry, but when, on our return, we opened these envelopes, sometimes containing six insects, we found the specimens beautifully preserved with a minimum amount of distortion.

In papering aeshnines and gomphines, instead of using the bit of glued cord at one end of the envelope, as is our custom, we usually used some common libelluline with a thorax sufficiently bulky to insure no pressure of the envelope on the abdomen of the other specimen. This worked as well as the glued cord and reduced the number of envelopes required to paper the day's catch.

In papering libellulines, in which it is desirable that the legs should not cover nor obstruct the view of the accessory genitalia, it was found that by taking the opened envelope in the left hand and by holding the wings of the insect with tweezers in the right hand, it was possible, without loss of time in papering, to brush the legs of the insect forward, over the edge of the envelope, thus entirely clearing the genitalia. This may seem a small matter except to one who has had occasion to examine the genitalia of a few hundred or thousand libellulines.

During our trip some of our killing bottles became "weak," and in several instances inert but not dead specimens were placed in the ordinary letter envelopes in the collecting box for transportation during the day. Such specimens, when they revived, chewed and tore other specimens placed in the envelopes with them. This was guarded against by using "strong" bottles for killing and weaker bottles for carrying material till a sufficient number had accumulated to justify opening the collecting box. Specimens with broken necks, caused by twisting the head, will not damage other specimens.

While papering material at night it was found that if the letter envelopes were white or light colored one could more readily see whether or not they were emptied of all specimens, since, in poor light, any insect clinging to the inside of an envelope is more readily seen in or through a white envelope. It was found desirable to letter or number these envelopes, designating three or four groups. For example, each one-fourth of the envelopes would be plainly labelled A, B, C, and D, respectively. In the field it is advisable that the specimens gathered in the same habitats or localities be placed in the envelopes similarly lettered. Such a procedure will facilitate papering the material in properly designated envelopes when the day's collecting is over. Other conditions also arise where separation of material during the day is desirable. Of course variously colored envelopes are even better than lettered or numbered envelopes, except for the reason given above for preferring white envelopes.

COMMON NAMES OF DRAGONFLIES

Mr. H. L. Tyrer, of Barranquilla, told us that so far as he knew caballito was the only name in common use in Colombia. At any rate in our limited experience we always found this name readily understood. Young men travelling with us on one of the river steamers told us that at Medellin

dragonflies were commonly called senoritas, and at Bogota they were called matapiojo. The first part of the latter name means a killer, and the last part an insect the same as or similar to the red bug,—in other words, the red bug killer. A well educated gentleman at Puerto Berrio said that in the Department of Antioquia dragonflies were called by the common people chilcaqua, from chiquear, to reduce, to make less and less, hence to flip or dip out, and from aqua, water, the name doubtless tracing back to some early observer of an ovipositing libelluline, very probably *Orthemis ferruginea*. One evening at El Banco when we had an audience of several persons while putting up our day's catch, we asked if the insects were called caballitos. To this we received an affirmative reply from everyone but a small boy who pointed to a zygopterous specimen and said "ceritongo" (cieratonga). The day's catch included libellulines, large and small, aeshnines, gomphines, and a mixture of zygopteras including Mecistogasters. We at once mixed up the lot and asked him to separate the caballitos and the ceritongos. As rapidly as he could pick them up with the tweezers he separated the anisopteras from the zygopteras without a mistake. Several persons questioned were unable to give us the meaning of the word, but one gentleman thought that it was probably derived from cerar, to shut or block off, and tonga, a current of water.

ACKNOWLEDGEMENTS

In concluding this narrative we wish to thank many friends and acquaintances not mentioned by name, who gave us advice and assistance, and added to the pleasure and effectiveness of our trip. At all times we were shown the greatest courtesy and kindness by those with whom we came in contact in Colombia.

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MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 4

Contributions to the Botany of Michigan

BY

C. K. DODGE

ANN ARBOR, MICHIGAN

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan

CONTENTS

PAGE

Introduction 5
Pellaea glabella 5
Cryptogramma Stelleri 6
Polystichum Braunii 6
Lycopodium tristachyum 6
Sparganium diversifolium var. *acaule* 7
Anthoxanthum odoratum 7
Aristida oligantha 7
Calamagrostis hyperborea 7
Calamagrostis inexpansa 8
Danthonia compressa 8
Spartina patens 8
Glyceria borealis 8
Eriophorum tenellum 9
Juncus Gerardi 9
Streptopus longipes 9
Salix pellita 9
Arceuthobium pusillum 10
Spergularia media 10
Amelanchier species 10
Geranium sanguinium 11
Viola selkirkii 11
Opuntia Rafinesquii 12
Osmorhiza species 12
Gentiana linearis var. *latifolia* 12
Collinsia parviflora 13
Mimulus moschatus 13
Digitalis purpurea 13
Solidago lepida var. *molina* 14
Adenocaulon bicolor 14
Hieracium aurantiacum 14

CONTRIBUTIONS TO THE BOTANY OF MICHIGAN

BY C. K. DODGE

INTRODUCTION

A considerable amount of data on the plants of the state has accumulated since the appearance of the last edition of W. J. Beal's Flora of Michigan.[1] Some of this data has been published but a large part is in the form of herbarium specimens, notes, and manuscripts. In his work on the phanerogamic flora of the state, carried on during the past ten years for the Michigan Geological and Biological Survey and the Museum of Zoology, the writer has been able to add a number of species to the known flora and to obtain much additional information on the ranges of many of the species. Some of this data has been published in local lists, but a large number of miscellaneous notes have not been appurtenant to the local lists and there has been in Michigan no suitable medium of publication for them. It is now purposed to publish such notes in the Miscellaneous Publications of the Museum of Zoology, under the general title Contributions to the Botany of Michigan, and to number these consecutively for ease in reference.

The present paper records a number of species new to the Michigan flora and extends the range of several forms. Unless otherwise stated specimens are in the writer's herbarium at Port Huron, Michigan.

Pellaea glabella Mett.

Smooth Cliff-brake

The smooth cliff-brake is perhaps very close to *P. atropurpurea* (L.) Link. It is not recognized in the last edition of Gray,[2] and it is given as a synonym of *P. atropurpurea* in Britton and Brown. It is not referred to in the last Michigan Flora. In 1905, while examining peat beds in the Upper Peninsula, the late Prof. C. A. Davis made a large collection from dry rocks near Norway, Dickinson County, of a fern that was then supposed to be *P. atropurpurea* but which has since been referred to *P. glabella.*

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[1] 5th Ann. Rept. Mich. Acad. Sci., 1904.

[2] The manuals referred to in this paper are Gray, New Manual of Botany, 7th edition, 1908; Britton and Brown, An Illustrated Flora of the Northern U. S., Canada and the British Possessions, 2nd Ed., 1913; and W. J. Beal, Michigan Flora, Fifth Annual Report Mich. Acad. Sci., 1904.

Cryptogramma Stelleri (Gmel.) Prantl
Slender Cliff-brake

As far as known to the writer this beautiful little fern is seldom seen in the state. The Michigan Flora reports it as found on Louse Isle and as seen by the late G. H. Hicks at the Pictured Rocks on the south shore of Lake Superior. In 1916 a visit was made to Grand Marais, Grand Island and Munising, and an attempt was made to reach the Pictured Rocks which lie between these two places. The old lumber roads and trails to the latter locality were found to be impassable, but at Munising conditions were more favorable and a search for the species was made at that place. The city is situated in a depression or valley surrounded by high abrupt hills covered with hardwoods. In the hills there are several small streams with overhanging rocky banks and precipitous falls. Under these overhanging rocks, in crevices or on little benches or projections, the slender cliff-brake was found in abundance, growing with *Cystopteris fragilis,* the brittle fern. A further search in similar places, at least in the Northern Peninsula, will undoubtedly bring to light other stations for this delicate species.

Polystichum Braunii (Spenner) Fee
Braun's Holly-fern

The Michigan Flora only mentions this fern as noted by O. A. Farwell in Keweenaw County. This would seem to indicate that it is scarce and has seldom been seen by our botanists, for, as compared with other ferns in the state, it is certainly very distinct. The writer observed it first in 1916, in the rich woods on Grand Island and near Peter White Camp in Alger County. In June, 1917, it was found to be very plentiful on the alluvial flood plain of the Salmon Trout River near the Huron Mountain Club on the south shore of Lake Superior, northwest of Marquette, Marquette County.

Lycopodium tristachyum Pursh
Clustered Club Moss, Ground Pine

The range of this club moss is given by Gray as "Dry sandy soil N. Me. to Del. and L. Superior," and by Britton and Brown as "Maine to Minnesota, etc." The Michigan Flora mentions it under the name of *L. Chamaecyparissus* A. Br. and says that it has been located in three places—Clare County, Keweenaw County, and near Manistee.

In 1908, while engaged in a botanical survey of the Saginaw Bay sand dune district, the writer found it in abundance in Huron County but at the time supposed it to be *L. complanatum* L. and so listed it. Since then it has been noted as quite common from Mackinac to Houghton and Keweenaw Counties inclusive.

Sparganium diversifolium Graebner var. **acaule**
(Beeby) Fernald and Eames
Stemless Bur-reed

The stemless bur-reed, given as a variety in Gray and as a species in Britton and Brown, has apparently been generally overlooked by Michigan botanists. There seems to be no published record, but the writer has found the species in several localities. In 1911 it was discovered on Harsen's Island in the southern part of St. Clair County, growing in abundance in muddy places and shallow water. In 1914 it was noted as abundant about Vermillion in Chippewa County, and in 1915 it was found to be common in Schoolcraft County. The plant very probably occurs throughout the state.

Anthoxanthum odoratum L.
Sweet Vernal Grass

This grass seems to have been naturalized from Europe. The habits and range are given by Gray as "Meadows, pastures and waste places, especially eastw."; and by Britton and Brown as "In fields and meadows throughout the whole of North America." The distribution given by the Michigan Flora is "Ionia; Grand Rapids, Coleman Cat.; well established in the college lawn. Rare." This would indicate that it is not at all common in the state. The writer saw it in abundance on and near the bank of Echo Lake, a small body of water in the woods of Grand Island, near Munising, Alger County, in 1914. It had the appearance of a native wild plant, but there are a number of buildings on the bank, and the lake is often visited.

Aristida oligantha Michx.
Few-flowered Aristida, Ant-rice

The habitat and range of this grass are given in Gray as "Dry sterile soil N. J. to Neb. and southw."; in Britton and Brown as "Dry soil; New Jersey to Nebraska, and Texas." It is not listed in the last Michigan Flora. To the writer's knowledge it has persisted in dry open ground near the city of Port Huron for about ten years.

Calamagrostis hyperborea Lange
Northern Reed-grass

The habitat and range of the northern reed-grass is given in Gray as "Moist meadows and calcareous cliffs, Greenl. to Alaska s. to e. Que., n. Vt., 'Pa.', Minn., and the Rocky Mts."; in Britton and Brown as "Meadows and swamps, Greenland to Alaska, south to Pennsylvania, Colorado and California." It is not listed in the Michigan Flora. In 1916 the writer observed the species to be very abundant in a meadow-like opening on the high bank of Lake Superior near Sable Banks, west of Grand Marais, in Alger County.

Calamagrostis inexpansa Gray

Bog Reed-grass

It is to be inferred that both Gray and Britton and Brown include Michigan in the range of this grass, although the state is not specifically mentioned. The Michigan Flora states in its additions that Dr. H. S. Pepoon saw it near Keeler, Van Buren County.

For over five years it has persisted in open wet ground along the Grand Trunk Railway near the city of Port Huron. It has perhaps been introduced at this point.

Danthonia compressa Aust.

Flattened Wild Oat-grass

This species is new to Michigan flora. The habitat and range are given by Gray as "Dry woods, Me. to N. Y. and southw.", and in Britton and Brown as "In woods, Maine to New York, south to North Carolina and Tenessee." The writer found it plentiful in several dry, open or partially shaded places in the northeastern part of Schoolcraft County in 1916.

Spartina patens (Ait.) Muhl.

Salt-Meadow Grass

The habitat of this grass is "salt meadows and sandy beaches" along the Atlantic coast. It grows in salty ground, and with *"Juncus Gerardi,* the 'black grass,' furnishes most of the salt meadow hay of the Atlantic coast." Both manuals substantially agree as to its habitat and range. It is not included in the Michigan Flora.

The species has become established and has persisted for over ten years in the Grand Trunk Railway freight yards above the Tunnel Station near the city of Port Huron. One mound in particular, about thirty feet long and fifteen feet wide, is snugly sodded over with salt-meadow grass to the exclusion of almost every other plant. A few rods distant *Juncus Gerardi* is very abundant. Appropriate soil conditions are furnished by salt water from a large ice house and many salt vats where refrigerator cars are iced before going farther east. The salt used with the ice is often scattered about in substantial quantities.

Glyceria borealis (Nash) Batchelder

Northern-manna Grass

Michigan is apparently included in the range of this plant by Gray and Britton and Brown, although the state is not specifically mentioned. In the latter it bears the scientific name *Panicularia borealis* Nash, and the same common name as *P. laxa* Scribn, a grass whose range appears to be farther east. It is not listed in the Michigan Flora. It has been observed by the writer as plentiful in damp open ground near Fostoria, Tuscola County, 1910, and near L'Anse, Baraga County, 1916.

Eriophorum tenellum Nutt.
Rough Cotton-grass

It is stated in Gray that the habitat and range of this cotton-grass is "Swamps and bogs. Nfd. to Ont. s. to N. J. and Ill.", and about the same distribution is given by Britton and Brown. It is not mentioned in the Michigan Flora.

In 1914 the species was noticed as frequent in swampy ground near Vermillion and at the lower falls of the Tahquamenon River, Chippewa County, and again near Newberry in Luce County. The writer believes this plant to be common throughout the eastern half of the Northern Peninsula.

Juncus Gerardi Loisel
Black Grass

The habitat of the black grass is given by Gray and Britton and Brown as "Salt marshes" and the range in part as "Vicinity of the Great Lakes." In the Michigan Flora it is listed as "Rare about the Great Lakes, Gray's Manual," which would indicate that it had been seldom seen in Michigan by our local botanists. As noted under *Spartina patens* it is found near Port Huron on soil which has become impregnated with salt in the icing of refrigerator cars. It has persisted here for more than ten years.

Streptopus longipes Fernald
Fernald's Streptopus

This plant was first described in 1906, and the description in Gray mentions the character, "rootstock slender and wide creeping" and gives in the range "woods Marquette Co., Mich." In the last edition of Britton and Brown it is thrown into synonymy. The writer is familar with the other two species in our territory, *S. roseus* and *S. amplexifolius,* and believes that *S. longipes* is a valid species. The only other Michigan records, so far as the writer has been able to ascertain, are those of Frank C. Gates[3] for Douglas Lake, Cheboygan County, Michigan.

In 1914 it was noted as common in Chippewa County, especially in the woods about Vermillion. It was again seen in Luce, Schoolcraft, Mackinac and Alger Counties in 1915, and was abundant in the hardwoods of Marquette County in 1916 and 1917. *S. roseus* was not observed in the last named county.

Salix pellita Anders.
Satiny Willow

The satiny willow apparently has not often been seen in Michigan. The manuals do not mention Michigan in its range and the Michigan Flora does not refer to it. W. S. Cooper[4] noted it on Isle Royale, and in 1915 the

[3] Rhodora, XIII (1911), p. 237; 14th Ann. Rept. Mich. Acad. Sci., 1912,p. 88.
[4] 16th Ann. Rept. Mich. Acad. Sci., 1914, p. 119.

writer found it in abundance along the low banks of the Tahquamenon River in Luce County. It was later located on swampy ground near Munising, Alger County, and on the margin of Pine Lake near the Huron Mountain Club, Marquette County. The under sides of the leaves are usually velvety-white, presenting a beautiful sight when turned up by a breeze. It is probably frequent throughout the Northern Peninsula.

Arceuthobium pusillum Peck

Dwarf Mistletoe

This small parasitic plant, known as *Arceuthobium pusillum* Peck in Gray's Mannual and as *Rozoumofskyan pusilla* (Peck) Kuntze, small mistletoe, in Britton and Brown is attributed to Michigan in Gray. The Michigan Flora mentions it as observed by the late Prof. C. F. Wheeler near Chatham, Alger County; by B. Barlow at Turin, Marquette County; and by the late Prof. C. A. Davis near Cadillac, Wexford County. In 1908, the writer saw it in abundance on black spruce in Huron County; in 1913 on white spruce, Bois Blanc Island, Mackinac County, and in 1916 on white spruce near Peter White Camp in the western part of Alger County. It is now probably well established throughout Michigan.

Spergularia media (L.) C. Presl.

Large Flowered Sand Spurry

This plant is described in Gray, and it is included in the description of *Tissa marina* (L.) Britton, salt-marsh sand spurry, in Britton and Brown. It is not mentioned in the Michigan Flora. The range given in Gray is "Near Selina, N. Y.; also Cal. (Eu.)". The plant has been well established and abundant for nearly ten years at the Grand Trunk freight yards near the city of Port Huron. It is mostly found on wet ground and covers a large area.

Amelanchier species

Juneberry

Gray describes four species and two varieties and Britton and Brown six species of this difficult genus. The Michigan Flora mentions six species. The species are so variable that there has been little unanimity of opinion as to their status, and the identification of specimens has been difficult. For the purpose of this paper it will be assumed that Prof. K. M. Wiegand's[5] revision of the eastern species is to be adopted by botanists generally. Eight species are recognized by Wiegand, seven of which occur in Michigan. The known species in the state so far as described by him will be taken up in order.

Amelanchier sanguinea (Pursh) DC. Round-leaved Juneberry.—Probably common throughout Michigan.

[5] Rhodora, Vol. 14, 1912, p. 117.

Amelanchier humilis Wieg. Small Juneberry.—Barren sand in Kent County; near Huron Mountain Club in Marquette County.

Amelanchier florida Lindley. Flowering Juneberry.—On Isle Royale; Keweenaw County; Alcona County; Alpena County.

Amelanchier stolonifera Wieg. Low Juneberry.—Alpena County; Marquette County; Huron County; Arenac County.

Amelanchier canadensis (L.) Medicus. Common Juneberry.—Probably common throughout the state. Often large trees.

Amelanchier laevis Wieg. Smooth-leaved Juneberry.—Probably abundant throughout the state. Trees often large.

Amelanchier Bartramiana (Tausch.) Roemer. Oblong-fruited Juneberry.—Keweenaw County; on Isle Royale; Chippewa County; Alger County.

To this list should be added the western species:

Amelanchier alnifolia Nutt. Northwestern Juneberry.—A western species. Dry open ground near Norway, Dickinson County, in 1905 by the late Prof. C. A. Davis; Presque Isle County; Keweenaw County, O. A. Farwell.

Geranium sanguinium L.

Red-rooted Geranium

Some time during the season of 1914, Miss R. M. Kearsley, of Detroit, observed an unfamilar road-side geranium near Birmingham, Oakland County. B. Gladewitz, of Detroit, determined the plant as *G. sanguinium*, and this identification has been confirmed by K. K. Mackenzie.

The species is from one to one and one-half feet high, inclined to be ascending, flowers purple and showy, petals heart-shaped, roots long and red—fully as red as the rootstocks of our common bloodroot, *Sanguinaria canadensis*. The plants occupy a space by the roadside about ten by twenty feet, extend slightly into an adjoining field and are reported by nearby people as having been there at least fifteen years.

Viola Selkirkii Pursh

Great-spurred Violet

According to Gray the range of this violet is in part "L. Superior and Northw., rare."; and in Britton and Brown the distribution is given in part as "New Brunswick to Pennsylvania and Minnesota." The Michigan Flora lists the following localities, "Gillman, A. Gray; Keweenaw County, O. A. Farwell. U. P." This violet is very distinct and easily recognized. It was first noted by the writer in the hardwoods near Manistique, in Schoolcraft County, and in 1916-7 it was observed frequently in rich, shaded ground in Marquette County, especially about the premises of the Huron Mountain Club. It is very probably to be found throughout the Upper Peninsula.

Opuntia Rafinesquii Engelm.

Western Prickly Pear

The above scientific name is given in Gray which specifically mentions Michigan as part of its range. Britton and Brown call it *O. humifusa* Raf., and the distribution is given as "Ohio to Minnesota, etc." In the Michigan Flora under the latter name the following localities are mentioned: "Common in Newago County along the Muskegon River, Cedar Creek Tp., Muskegon Co., C. F. Wheeler; and a stunted variety on sand barrens near Greebville, J. Satterlee; also northward into British Am., Englemann."

The writer first saw the species in 1910, on Point Pelee, Essex County, Ontario. In September, 1916, while making a botanical survey about the Huron Mountain Club in Marquette County, Michigan, Miss Anne Russell, of Detroit, discovered it in rocky places on a near-by granite hill known as Huron Mountain. In August, 1917, the writer noted it as plentiful about New Buffalo, Berrien County. It has been reported on rocky hills about the city of Marquette and on sandy open ground west of Alpena in Alpena County.

Osmorhiza species

The Sweet Cicelies

In Gray and Britton and Brown four species and one variety of sweet cicely are mentioned and described. In Britton and Brown the generic name is Washingtonia, in Gray, Osmorhiza. In this paper the latter name will be used. The manuals apparently do not specifically credit Michigan with more than two species, *Osmorhiza Claytoni* (Michx.) Clarke, woolly sweet cicely, and *O. longistylis* (Torr.) DC., smoother sweet cicely. The Michigan Flora mentions these two and reports them common throughout the state. The variety *O. longistylis villicaulis* Fernald, pubescent smoother sweet cicely, has been noted as frequent from St. Clair County north and west to Delta County. In 1907, the writer discovered *O. divaricata* Nutt., western sweet cicely, in rich shaded ground on Thunder Bay Island, Alpena County,[6] and again in rich woods near Eckerman, Chippewa County, in 1914. In the same year *O. obtusa* (Coult. & Rose) Fernald, blunt-fruited sweet cicely, was noted in rich woods in Chippewa County and throughout Alger County. It appears that the last two species may be considered abundant throughout the eastern part of the Upper Peninsula, and perhaps occasional in the northern part of the Lower Peninsula.

Gentiana linearis Froel. var. **latifolia** Gray

Gray's Gentian

Gray's gentian is listed in Gray under the above scientific name and the range is given as "Lake Superior; N. B." Britton and Brown record the species as *Dasystephana grayi* (Kusnezow) Britton. There is no reference

[6] Additions to the Michigan Flora, by W. J. Beal. 10th Ann. Rept. Mich. Acad. Sci., 1908, p. 89.

to it in the Michigan Flora. In the course of botanical work in the eastern part of the Northern Peninsula, from 1912 to 1917, the writer found it abundant on damp, open or partially shaded ground on Bois Blanc Island, about St. Ignace, and in all the northern counties from Macinac to Marquette inclusive.

Collinsia parviflora Lindl.
Small-flowered Collinsia

This little plant is given in Gray, and its habitat and range are described as "Rich soil and limy gravel, Ont. N. Mich. and westw." In Britton and Brown it goes by the name of *C. tenella* (Pursh) Piper, and the habitat and range are given as "Moist places, Ontario to British Columbia, Michigan, Colorado, Arizona and Utah." The Michigan Flora mentions only one Michigan record, Keweenaw County, observed by O. A. Farwell. Owing to the fact that it is usually only three to six inches long and grows in obscure places it easily escapes observation. In early June, 1917, it was found by Mr. B. Gladewitz and the writer in Marquette County, where it grew in abundance in rock cracks and crevices on the summit and sides of a large granitic hill known as Huron Mountain. It is very probably to be found in like places throughout the county.

Mimulus moschatus Dougl.
Musk Flower

Both Gray and Britton and Brown give Michigan in the range of this plant and intimate that perhaps it has been introduced from the west. In the Michigan Flora it is mentioned as having been observed by O. A. Farwell in Keweenaw County. The writer found it plentiful about Grand Marais in Alger County in 1916, where it occurs in damp places mostly along roads but also in other damp open spots. It may have been introduced.

Digitalis purpurea L.
Purple Foxglove

Both Gray and Britton and Brown substantially agree that this plant is "naturalized from Europe, sparingly escaped from cultivation." It is not only cultivated as an ornamental plant but it is a valuable and much used drug sold under the name of digitalis. It is not mentioned in the Michigan Flora as an escape in the state. In 1916, in company with Mr. George W. Howe of Port Huron, Michigan, the writer collected in the territory adjacent to the south shore of Lake Superior. Among other places visited was the Peter White Camp, a beautiful place about ten miles from the south shore of Lake Superior, in the western part of Alger County. The purple foxglove was growing wild at this place and also at Howe's Lake, a small body of water near by. Howe's Lake is surrounded by primitive forests and only a short distance from its margin, but entirely hidden from view from the lake, was discovered a small clearing of perhaps a quarter of an acre in extent with two very old log hunting huts. The camps and clearing

had the appearance of having been abandoned for many years. In this clearing the purple foxglove was holding its own with grass and weeds; there were many plants five feet high, and varieties with both white and purple flowers were present. Its companion was the sweet william, *Dianthus barbatus* L. We were informed that these plants had been growing wild there for over thirty-five years.

Solidago lepida DC., var. **molina** Fernald

Woolly Goldenrod

In 1916, while engaged in a botanical survey of a part of the south shore of Lake Superior, the writer collected near L'Anse, Baraga County, and also in Houghton County a very woolly stemmed goldenrod, usually in open places not far from the lake shore. Specimens were referred to Mr. K. K. Mackenzie, who identified them as *S. lepida* Fernald, the original description of which appeared in Rhodora, Vol. 17, p. 8 (1915).

Adenocaulon bicolor Hook

Adenocaulon

As far as can be ascertained Michigan botanists know very little about this plant. The range is given in Gray as "Moist woods, shores of Lake Huron, Lake Superior, and westward," in Britton and Brown as "In moist woods, northern Michigan and Lake Superior to British Columbia, Montana and California," and in the Michigan Flora as "Ontonagon River, U. P." In June, 1916, the writer found it to be plentiful near Peter White Camp in the western part of Alger County, and again, in September of the same year, in open hardwoods at the foot of Huron Mountain in the northwestern part of Marquette County.

Hieracium aurantiacum L.

Orange Hawkweed

The orange hawkweed is now well known in the state, especially in the Lower Peninsula, and the manuals give it a wide range as a weed and pest from Europe. Curiously enough, it has only once been recorded for Michigan,—in the writer's Mackinac Island list. In the late Prof. C. F. Wheeler's annotated copy of Beal and Wheeler's Michigan Flora is the note "*Hieracium aurantiacum* is becoming a weed near Huron (Lenawee County)." It is omitted in the last Michigan Flora. In 1912, the writer examined the wild plants on or near Lake Huron shore from near Bay City to Mackinaw City. This species was abundant in fields and on roadsides just north of Alpena, where farmers reported that it had been noted for many years, and it was common even in the open woods from Alpena to Mackinaw City.

UNIVERSITY OF MICHIGAN

MUSEUM OF ZOOLOGY

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Contributions to the Botany of Michigan, II

BY

C. K. DODGE

ANN ARBOR, MICHIGAN

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

OBSERVATIONS ON THE FLOWERING PLANTS, FERNS AND FERN ALLIES GROWING WILD IN MARQUETTE COUNTY, MICHIGAN, IN 1916 AND 1917, ESPECIALLY IN THE VICINITY OF THE HURON MOUNTAIN CLUB

By Charles Keene Dodge

Introductory Note

The manuscript of this paper was completed by Mr. Dodge shortly before his death. It represents the results of several field trips to Marquette County, the last in the spring of 1917, in the course of an investigation of the phanerogamic flora of the state upon which he had been engaged for the Michigan Geological and Biological Survey. Two trips were made to the Huron Mountains, in the summer of 1916 and the early spring of 1917, and on the second trip Mr. Dodge was accompanied by Mr. B. Gladewitz. The mountains are specifically mentioned as a locality in the paper for the convenience of the summer residents, and a map of the part most carefully worked is appended.

The paper has been edited for publication by Messrs. C. Billington and B. Gladewitz.

Alexander G. Ruthven.

List of Species

POLYPODIACEAE

Polypodium vulgare L. Common Polypody.—Rocky, usually shaded ground, often protruding from cracks and crevices of rocks on Huron Mountain, a large granitic hill near Huron Mountain Club, and in rocky places throughout Marquette County. Often abundant.

Phegopteris polypodioides Fée. (*Dryopteris phegopteris* L., C. Chr.). Long Beech Fern.—Rich woods and shaded banks of small streams near Huron Mountain Club and throughout Marquette County. Plentiful.

Phegopteris Dryopteris (L.) Fée. (*Dryopteris dryopteris* L., Britton). Oak Fern.—Rich moist woods near Huron Mountain Club and throughout Marquette County. Often abundant.

Adiantum pedatum L. Maidenhair Fern.—Rich shaded ground throughout. Plentiful along Salmon Trout River near Huron Mountain Club.

Pteris aquilina L. (*Pteridium aquilinum* L., Kuhn). Common Brake.—Dry, sandy, open or partially shaded ground near Huron Mountain Club. Plentiful throughout. Often in swamps.

Asplenium Trichomanes L. Maidenhair Spleenwort.—Cracks and crevices of perpendicular rocks at Canyon Lake near Huron Mountain Club, and propably on shaded rocks throughout. Noted by B. Gladewitz.

Asplenium acrostichoides Sw. (*Athyrium thelypteroides* Michx., Desv.). Silvery Spleenwort.—Rich shaded ground near Negaunee. Perhaps frequent throughout.

Asplenium Filix-femina (L.) Bernh. (*Athyrium filix-foemina* L., Roth.). Lady Fern.—Rich open or shaded ground near Huron Mountain Club. Abundant throughout.

Polystichum acrostichoides (Michx.) Schott. Christmas Fern.—Rich woods and shaded rocky ground about Sugar Loaf Mountain near Marquette. Very probably to be found throughout the county. Apparently infrequent.

Polystichum Braunii (Spenner) Fée. Braun's Holly Fern.—Occasional throughout, but plentiful in rich shaded ground along Salmon Trout River near Huron Mountain Club.

Aspidium Thelypteris (L.) Sw. (*Dryopteris thelypteris* L., A. Gray). Marsh Shield Fern.—Marshy open or partially shaded ground near Huron Mountain Club. Plentiful and often abundant throughout.

Aspidium noveboracense (L.) Sw. (*Dryopteris noveboracensis* L., A. Gray). New York Fern.—Rich woods about Sugar Loaf Mountain near Marquette. Apparently infrequent.

Aspidium fragrans (L.) Sw. (*Dryopteris fragrans* L., Schott.). Fragrant Shield Fern.—Rocky granitic hills about Huron Mountain Club. Apparently infrequent. Noted by Mrs. Wallace Radcliffe.

Aspidium marginale (L.) Sw. (*Dryopteris marginalis* L., A. Gray). Evergreen Wood Fern.—Rich shaded ground throughout. Observed in particular as plentiful on wooded sides of Huron Mountain near Huron Mountain Club.

Aspidium Boottii Tuckerm. (*Dryopteris Boottii* Tuckerm., Underw.). Boott's Shield Fern.—Damp shaded ground near Negaunee. Apparently infrequent.

Aspidium cristatum (L.) Sw. (*Dryopteris cristata* L., A. Gray). Crested Shield Fern.—Damp open or partially shaded ground near Huron Mountain Club. Probably frequent throughout.

Aspidium spinulosum (O. F. Müller) Sw. (*Dryopteris spinulosa* Muell., Kuntze.). Spinulose Shield Fern.—In hardwoods near Huron Mountain Club. Common throughout.

Aspidium spinulosum intermedium (Muhl.) D. C. Eaton. (*Dryopteris intermedia* Muhl., Gray). American Shield Fern.—Frequent in damp rich woods near Huron Mountain Club and throughout.

Cystopteris bulbifera (L.) Bernh. (*Filix bulbifera* L., Underw.). Bulblet Cystopteris.—Shaded rocky ravines about Marquette and Huron Mountain Club. Plentiful.

Cystopteris fragilis (L.) Bernh. (*Filix fragilis* L., Underw.). Brittle Fern.—Rich woods and shaded rocks near Huron Mountain Club and about Marquette. Plentiful. A delicate little fern.

Woodsia ilvensis (L.) R. Br. Rusty Woodsia.—Cracks and crevices of rocks on Huron Mountain near Huron Mountain Club. Plentiful.

Woodsia obtusa (Spreng.) Torr. Blunt-lobed Woodsia.—In crecks and crevices of rocks on Sugar Loaf Mountain near Marquette. Abundant. Probably to be found throughout.

Onoclea sensibilis L. Sensitive Fern.—Damp open or partially shaded ground near Huron Mountain Club. Plentiful throughout.

Onoclea Struthiopteris (L.) Hoffm. (*Matteuccia Struthiopteris* L., Todaro). Ostrich Fern.—Near Huron Mountain Club in alluvial ground, along small streams and in damp rich partially shaded ground. Frequent throughout. A fine fern for cultivation.

OSMUNDACEAE

Osmunda regalis L. Royal Fern.—Wet rich shaded ground near Huron Mountain Club. Plentiful throughout.

Osmunda Claytoniana L. Clayton's Fern, Interrupted Fern. — Damp rich open or partially shaded ground near Huron Mountain Club. A large and beautiful fern. Frequent.

Osmunda cinnamomea L. Cinnamon Fern.—Open or partially shaded places near Huron Mountain Club. Frequent throughout.

OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw. Rattlesnake Fern, Virginia Grape Fern.—Rich shaded ground near Huron Mountain Club. Frequent throughout.

EQUISETACEAE

Equisetum arvense L. Common Horsetail.—In damp, dry, sandy, open or shaded ground near Huron Mountain Club. Common throughout. Often acting as an efficient sand binder.

Equisetum sylvaticum L. Wood Horstetail.—Damp shaded ground near Huron Mountain Club. Frequent throughout.

Equisetum fluviatile L. Swamp Horsetail. — Near Huron Mountain Club in very wet places, or still shallow water. Common.

Equisetum hyemale intermedium A. A. Eaton. (*E. hyemale* L.). Scouring Rush.—Dry open or shaded ground near Huron Mountain Club. Frequent and in spots abundant throughout, often acting as an efficient sand binder.

Equisetum variegatum Schleich. Variegated Equisetum.—Lake shores near Huron Mountain Club. Frequent throughout.

LYCOPODIACEAE

Lycopodium lucidulum Michx. Shining Club Moss. — Damp shaded ground near Huron Mountain Club. Frequent throughout.

Lycopodium inundatum L. Bog Club Moss.—Damp sandy open or partially shaded ground near Huron Mountain Club. Frequent throughout.

Lycopodium annotinum L. Stiff Club Moss.—Open hardwoods near Huron Mountain Club. Plentiful and often abundant throughout.

Lycopodium clavatum L. Common Club Moss, Christmas Green.—Dry, shaded ground near Huron Mountain Club. Frequent and often abundant throughout.

Lycopodium obscurum L. Ground Pine.—Rich shaded ground, usually in woods. Apparently frequent near Huron Mountain Club and throughout. It appears to be difficult to distinguish this from the following.

Lycopodium obscurum dendroideum (Michx.) D. C. Eaton. Tree-like Club Moss.—Woods about Huron Mountain Club, and plentiful throughout. Included by many botanists in the preceding.

Lycopodium tristachyum Pursh. Festoon Ground Pine, Ground Pine. —In sandy ground among pines near Huron Mountain Club and plentiful throughout.

SELAGINELLACEAE

Selaginella rupestris (L.) Spring. Rock Selaginella.—Dry rocks at the "Fortress" on Huron Mountain, near Huron Mountain Club. Plentiful throughout in similar situations.

Selaginella apus (L.) Spring. Creeping Selaginella.—Damp, mostly shaded ground near Huron Mountain Club. Plentiful throughout.

ISOETACEAE

Isoëtes macrospora Dur. Lake Quillwort.—In shallow water on margin of Rush Lake near Huron Mountain Club. Abundant. Perhaps to be found in most of the small lakes in the county.

TAXACEAE

Taxus canadensis Marsh. American Yew, Ground Hemlock.—A low evergreen straggling shrub with diffuse stems in hardwoods near Huron Mountain Club. Plentiful throughout.

PINACEAE

Pinus Strobus L. White Pine.—A few large trees left among hardwoods near Huron Mountain Club and throughout the county. Often a very large tree from 70 to 175 feet high with a trunk diameter from one and one-half to ten and one-half feet. Various common names have been given it by land lookers, lumbermen and others. Fat pine is the old resinous part taken from stumps and old logs and used for fuel. Cork pine is applied to very large and old trees with soft wood. A large tree, free from limbs and containing several logs of sixteen feet each, is called by land cruisers sap pine, and one with limbs on the body nearly to the ground, buckwheat pine.

Pinus Banksiana Lamb. Jack Pine.—Usually in dry sandy ground. Plentiful near Huron Mountain Club and throughout.

Pinus resinosa Ait. Red Pine, Norway Pine.—In dry sandy ground near Huron Mountain Club. Plentiful throughout. A tree, with body free from limbs, containing several logs of sixteen feet each is known as yellow pine

by land cruisers, one with limbs near the ground, buckwheat pine. When logs of this species are or become so heavy as to sink in water many lumbermen call them pig-iron pine.

Larix laricina (Du Roi) Koch. Tamarack, American Larch.—In swamps near Huron Mountain Club and frequent throughout.

Picea canadensis (Mill.) BSP. White Spruce.—Dry ground often on margins of hardwoods near Huron Mountain Club. Frequent throughout.

Picea mariana (Mill.) BSP. Black Spruce.—Usually in swamps with tamaracks and noted near Huron Mountain Club. Plentiful throughout in such situations.

Abies balsamea (L.) Mill. Balsam Fir, Balsam.—In and on the margin of hardwoods near Huron Mountain Club. Frequent throughout.

Tsuga canadensis (L.) Carr. Hemlock.—Often large trees on the margin of and in hardwoods near Huron Mountain Club. Plentiful throughout. Large trees are called yellow hemlock, and second growth white hemlock by land cruisers.

Thuja occidentalis L. White Cedar, Arbor Vitae.—In damp open hardwoods and swamps near Huron Mountain Club. Plentiful throughout. Formerly abundant in "cedar swamps", but lumbering and destructive fires have in many places nearly exterminated it. Small trees often grow on or near sandy beaches. As understood by land cruisers, second growth trees and those having bodies covered with limbs to or nearly to the ground are white cedar; those with tall smooth bodies mostly without limbs but with small tops are yellow cedar.

Juniperus communis L. Common Juniper.—On granitic hills near Huron Mountain Club. Small and apparently infrequent. The difference between this and the following, where the trees are mere shrubs, does not seem to be so very clear. This species when well developed is quite tree-like.

Juniperus communis depressa Pursh. (*J. Sibirica* Burgsd.) Low Juniper.—Near Huron Mountain Club along sandy beaches and in rocky places. Plentiful throughout.

TYPHACEAE

Typha latifolia L. Common Cat-tail. — In wet marshy and swampy places near Huron Mountain Club. Plentiful throughout.

SPARGANIACEAE

Sparganium eurycarpum Engelm. Broad-fruited Bur-reed.—Borders of ponds, lakes and streams near Huron Mountain Club. Plentiful throughout.

Sparganium americanum androcladum (Engelm.) Fernald & Eames. (*S. androcladum* Engelm., Morong.). Branching Bur-reed.—Third Pine Lake near Huron Mountain Club. Frequent throughout.

Sparganium diversifolium acaule (Beeby) Fernald & Eames. (*S. acaule* Beeby, Rydb.). Stemless Bur-reed.—Wet muddy places and in shallow water. Third Pine Lake, at the "Styx" near Huron Mountain Club, and probably frequent throughout.

NAJADACEAE

Potamogeton natans L. Common Floating Pondweed.—In all the small lakes near Huron Mountain Club. Common throughout.

Potamogeton epihydrus Raf. Nuttall's Pondweed.—In small lakes near Huron Mountain Club. Frequent throughout.

Potamogeton amplifolius Tuckerm. Large-leaved Pondweed.—Common in small lakes near Huron Mountain Club and throughout.

Potamogeton heterophyllus Schreb. Various-leaved Pondweed.—Abundant in small lakes near Huron Mountain Club, and throughout.

Potamogeton Richardsonii (Benn.) Rydb. Richardson's Pondweed.—Common in the small lakes near Huron Mountain Club, and probably throughout.

Potamogeton perfoliatus L. Clasping-leaved Pondweed.—Plentiful in small lakes near Huron Mountain Club and very probably throughout.

Potamogeton zosterifolius Schumacher. (*P. compressa* L.). Eel-grass Pondweed.—Abundant in small lakes near Huron Mountain Club and throughout.

Potamogeton pusillus L. Small Pondweed.—On margins of small lakes, in pools, ditches, small slow streams and ponds near Huron Mountain Club. Abundant throughout.

Potamogeton dimorphus Raf. Spiral Pondweed.—In small lakes near Huron Mountain Club and throughout. Plentiful.

Najas flexilis (Willd.) Rostk. & Schmidt. Slender Najas.—In shallow water of small lakes near Huron Mountain Club. Plentiful throughout.

JUNCAGINACEAE

Triglochin maritima L. Seaside Arrow Grass.—Marshy open ground near Marquette. Apparently infrequent.

ALISMACEAE

Sagittaria latifolia Willd. Broad-leaved Arrow-head. — In wet places and shallow water near Huron Mountain Club and Big Bay. Common throughout.

Sagittaria graminea Michx. Grass-leaved Sagittaria.—Third Pine Lake in shallow water by the "Styx" near Huron Mountain Club. Occasional throughout.

Alisma Plantago-aquatica L. (*Alisma Subcordatum* Raf.). American Water Plantain.—Shallow water on margins of small lakes, along small streams, in ponds and ditches near Huron Mountain Club. Plentiful throughout.

HYDROCHARITACEAE

Elodea canadensis Michx. (*Philotria canadensis* Michx., Britton). Water-weed.—Common in water of small lakes, ponds and sluggish streams near Huron Mountain Club, and throughout.

Vallisneria spiralis L. Tape Grass, Wild Celery.—Common and often abundant in water of small lakes near Huron Mountain Club and throughout.

GRAMINEAE

Andropogon scoparius Michx. (*Schizachyrium scoparium* Michx., Nash). Broom Beard Grass.—Dry sandy or rocky ground near Huron Mountain Club. Apparently infrequent.

Andropogon furcatus Muhl. Forked Beard Grass.—Dry open ground near Marquette. Apparently infrequent.

Digitaria humifusa Pers. (*Syntherisma ischaemum* Schreb., Nash). Small Crab Grass.—Cultivated and waste grounds in and about Marquette. Frequent.

Digitaria sanguinalis (L.) Scop. (*Syntherisma Sanguinale* L., Dulac.). Large Crab Grass, Finger Grass.—A weed in fields, gardens and waste places of cities and villages. Plentiful.

Panicum capillare L. Old Witch Grass.—In dry sandy ground as a weed in and about cities and villages. Often abundant.

Panicum depauperatum Muhl. Starved Panicum.—Dry sandy ground and on granitic rocky hills near Huron Mountain Club. Noted throughout as plentiful.

Panicum huachucae Ashe. Hairy Panic Grass. — Abundant on sandy beach of First Pine Lake near Huron Mountain Club. Plentiful throughout

Panicum xanthophysum Gray. Slender Panic Grass.—Rocky places on Huron Mountain near Huron Mountain Club. Probably frequent throughout.

Echinochloa crusgalli (L.) Beauv. Barnyard Grass.—A common weed in fields, gardens and waste places. Plentiful throughout. Prefers damp open ground. Variable.

Echinochloa muricata (Michx.) Fernald. Prostrate Cockspur Grass.—See Rhodora, 17, 198, June 1915. A grass not yet mentioned in the manuals. Prostrate, forming large mats in damp sand near Big Bay. Perhaps not always prostrate.

Setaria glauca (L.) Beauv. (*Chaetochloa glauca* L., Scribn.). Yellow Foxtail, Pigeon Grass.—A common weed in fields, gardens and waste places throughout.

Setaria viridis (L.) Beauv. (*Chaetochloa viridis* L., Scribn.). Green Foxtail Grass.—A common weed in fields, gardens and waste places throughout.

Cenchrus carolinianus Walt. Small Bur Grass.—In sandy open ground and waste places in and about cities and villages. Apparently infrequent.

Zizania palustris L. Wild Rice.—In shallow water of Third Pine Lake by the "Styx" near Huron Mountain Club. Apparently infrequent.

Leersia oryzoides (L.) Sw. (*Homalocenchrus oryzoides* L., Poll.). Rice Cut-grass, Scratch Grass.—Wet, usually open places about Marquette. Apparently infrequent.

Phalaris arundinacea L. Reed Canary Grass.—Open wet ground near Marquette. Frequent.

Milium effusum L. Tall Millet Grass.—In hardwoods about Huron Mountain Club. Plentiful throughout.

Oryzopsis pungens (Torr.) Hitchc. Slender Mountain Rice.—Dry sandy open ground near Huron Mountain Club. Plentiful throughout.

Oryzopsis asperifolia Michx. White-grained Mountain Rice.—In partially shaded ground, usually woods, near Huron Mountain Club. Frequent throughout.

Muhlenbergia sylvatica Torr. (*Muhlenbergia umbrosa* Scribn.). Woodland Drop-seed.—Shaded ground near Big Bay. Apparently infrequent.

Muhlenbergia racemosa (Michx.) BSP. Satin Grass, Wild Timothy.—Borders of marshy places and in damp meadow-like ground about Marquette. Frequent throughout.

Brachyelytrum erectum (Schreb.) Beauv. Bearded Short-husk.—Damp rich shaded ground near Huron Mountain Club. Frequent throughout.

Phleum pratense L. Timothy.—Plentiful throughout as an escape from cultivation to roadsides and open woods.

Alopecurus geniculatus aristulatus Torr. (*A. Aristulatus* Michx.). Short-awned Foxtail.—Wet places and often in shallow water. Noted at Big Bay and near Negaunee. Frequent.

Agrostis alba L. Red Top.—Dry sandy places or in damp meadow-like ground. Frequent throughout.

Agrostis hyemalis (Walt.) BSP. Rough Hair Grass, Fool Hay.—Dry or damp, open or partially shaded ground near Huron Mountain Club and throughout.

Calamovilfa longifolia (Hook.) Hack. Long-leaved Reed Grass.—Sandy beach of Lake Superior near Huron Mountain Club and often on sand dunes along the Great Lakes acting as an efficient sand binder against the action of wind.

Calamagrostis canadensis (Michx.) Beauv. Blue-joint Grass.—Wet open marshy places near Huron Mountain Club. Plentiful throughout.

Ammophila arenaria (L.) Link. Sea Sand-reed.—Sandy beach of Lake Superior near Huron Mountain Club. One of the most efficient sand binders against the action of wind and wave. Common and often abundant along the Great Lakes.

Cinna arundinacea L. Wood Reed Grass.—On wooded hillsides of Huron Mountain near Huron Mountain Club. Frequent throughout.

Cinna latifolia (Trev.) Griseb.—Damp open woods near Huron Mountain Club. Apparently infrequent.

Trisetum spicatum (L.) Richter. Narrow False Oat.—Noted in rocky places about Marquette by the late Rev. E. J. Hill and reported in Beal's Michigan Flora.

Deschampsia flexuosa (L.) Trin. Wavy Hair Grass.—Open dry or partially shaded places near Huron Mountain Club. Frequent throughout.

Danthonia spicata (L.) Beauv. Common Wild Oat Grass.—Open dry and sterile ground near Huron Mountain Club. Common throughout.

Phragmites communis Trin. (*Phragmites phragmites* L., Karst.). Common Red Grass.—Borders of tamarack-black spruce swamps near Huron Mountain Club. Frequent throughout.

Eragrostis pilosa (L.) Beauv. Small Tufted Love Grass.—Dry open ground in Marquette and other cities and along railroads. Frequent.

Eragrostis megastachya (Koeler) Link. (*E. Major* Host.). Strong-scented Love Grass.—A frequent weed in gardens and waste places throughout.

Melica Smithii (Porter) Vasey. (*Avena Smithii* Porter). Smith's Oat. —Moist open woods near Huron Mountain Club. Apparently infrequent.

Dactylis glomerata L. Orchard Grass.—In cities and villages and along railroads. Frequent.

Poa annua L. Dwarf Meadow Grass.—A small grass growing in lawns and waste places throughout. Plentiful.

Poa compressa L. English Blue Grass.—In dry sterile open ground near Huron Mountain Club. Frequent throughout.

Poa triflora Gilib. Fowl Meadow Grass.—Damp open places near Big Bay. Apparently infrequent.

Poa pratensis L. Kentucky Blue Grass, June Grass.—The common grass of our lawns, fields, roadsides and open woods. Abundant.

Poa alsodes Gray. Grove Meadow Grass.—Roadsides near Big Bay. Apparently infrequent.

Glyceria canadensis (Michx.) Trin. (*Panicularia canadensis* Michx., Kuntze). Rattlesnake Grass.—Wet and boggy places near Huron Mountain Club. Plentiful throughout.

Glyceria nervata (Willd.) Trin. (*Panicularia nervata* Willd., Kuntze). Nerved Manna Grass, Meadow Grass. — Moist open or partially shaded ground near Huron Mountain Club. Plentiful throughout.

Glyceria grandis Wats. (*Panicularia grandis* S. Wats., Nash). Reed Meadow Grass.—Low banks of streams, ditches and wet meadow-like ground near Huron Mountain Club. Frequent throughout.

Glyceria septentrionalis Hitchc. (*Panicularia Septentrionalis* Hitchc., Bicknell). Floating Manna Grass.—In shallow water near Huron Mountain Club. Frequent throughout.

Glyceria borealis (Nash) Batchelder. (*Panicularia borealis* Nash). Northern Manna Grass.—In shallow water on border of Third Pine Lake at the "Styx" near Huron Mountain Club. Apparently infrequent.

Festuca octoflora Walt. Slender Fescue Grass.—Dry sterile open ground near Huron Mountain Club. Frequent throughout.

Festuca ovina L. Sheep's Fescue.—Along sandy beach near Huron Mountain Club. Frequent throughout.

Festuca nutans Spreng. Nodding Fescue Grass.—In and on borders of moist woods near Huron Mountain Club. Frequent throughout.

Bromus secalinus L. Common Chess.—About cities and villages and along railroads. Frequent.

Bromus ciliatus L. Fringed Brome Grass.—Moist shaded ground near Huron Mountain Club. Frequent throughout.

Agropyron repens (L.) Beauv. Quack Grass.—A vicious weed in fields, gardens and on roadsides throughout. Plentiful.

Agropyron tenerum Vasey. Slender Wheat Grass. — Sandy beach of Lake Superior near Huron Mountain Club. Plentiful.

Hordeum jubatum L. Squirrel-tail Grass.—In cities and villages as a weed. A grass introduced from the west.

Elymus virginicus L. Virginia Wild Rye.—Margins of small streams and hardwoods near Huron Mountain Club. Frequent throughout.

Elymus canadensis L. Nodding Wild Rye.—Dry sandy ground near Huron Mountain Club. Common throughout. Often plentiful along the sandy beaches of Lake Superior where it acts as an efficient sand binder.

Hystrix patula Moench. (*Hystrix hystrix* L., Millsp.). Bottle-brush Grass.—Moist shaded ground near Huron Mountain Club. Frequent throughout.

CYPERACEAE

Dulichium arundinaceum (L.) Britton. Dulichium.—Borders of ponds and in wet places near Huron Mountain Club. Frequent throughout.

Eleocharis obtusa (Willd.) Schultes. Blunt Spike Rush.—Wet open places near Huron Mountain Club. Noted in great abundance in wet sand near Big Bay.

Eleocharis palustris (L.) R. & S. Creeping Spike Rush.—In damp open ground and often in shallow water near Huron Mountain Club. Plentiful throughout.

Eleocharis palustris vigens Bailey. Large Spike Rush.—Usually in shallow water on borders of ponds and small lakes. Noticed in pastures as abundant on the margin of Rush Lake.

Eleocharis acicularis (L.) R. & S. Needle Spike Rush.—Wet muddy shores near Huron Mountain Club. Abundant throughout.

Eleocharis tenuis (Willd.) Schultes. Slender Spike Rush.—Damp open ground and marshy places. Frequent throughout.

Scirpus hudsonianus (Michx.) Fernald. (*Eriophorum alpinum* L.). Alpine Cotton Grass.—Wet marshy places near Marquette. Plentiful throughout.

Scirpus subterminalis Torr. Water Club Rush.—In shallow water on border of Mountain Lake near Huron Mountain Club. Probably frequent throughout.

Scirpus americanus Pers. Three Square.—Borders of ponds, streams and small lakes near Huron Mountain Club. Plentiful throughout. Stems sharply three-angled.

Scirpus validus Vahl. American Great Bulrush.—Margins of ponds, streams and small lakes near Huron Mountain Club. Plentiful throughout.

Scirpus occidentalis (Wats.) Chase. Viscid Great Bulrush.—Borders of lakes and often in 6 or 7 feet of water. Stems 6 to 10 feet long. Frequent throughout.

Scirpus rubrotinctus Fernald. (*S. microcarpus* Presl.). Small-fruited Bulrush.—Very wet open places near Marquette and Big Bay. Plentiful.

Scirpus atrovirens Muhl. Dark-green Bulrush.—Bogs and damp meadow-like ground near Huron Mountain Club. Plentiful throughout.

Scirpus cyperinus pelius Fernald. Wool Grass.—Open marshy or boggy ground near Huron Mountain Club. Abundant throughout. This is supposed to be included in *S. Cyperinus* (L.) Kuntze in Britton & Brown.

Scirpus pedicellatus Fernald. Pedicelled Wool Grass.—Marshy open or partially shaded ground near Huron Mountain Club. Frequent.

Scirpus atrocinctus Fernald. Fernald's Bulrush.—Damp meadow-like and swampy ground near Huron Mountain Club. Plentiful.

Eriophorum callitrix Cham. Sheathed Cotton Grass, Hare's Tail.—Open boggy ground near Huron Mountain Club. Frequent throughout.

Eriophorum gracile Roth. Slender Cotton Grass.—Wet open boggy places about Marquette. Frequent.

Eriophorum angustifolium Roth. Tall Cotton Grass.—Wet marshy open places near Marquette. Frequent.

Eriophorum viridi-carinatum (Engelm.) Fernald. Thin-leaved Cotton Grass.—Margin of and in open spots of tamarack-black spruce swamps near Huron Mountain Club. Frequent throughout.

Eriophorum virginicum L. Virginia Cotton Grass.—Damp open meadow-like or boggy ground near Huron Mountain Club. Plentiful throughout.

Rynchospora alba (L.) Vahl. White Beak Rush.—Open boggy ground near Marquette. Plentiful.

Carex Crawfordii Fernald. Crawford's Sedge.—Dryish open ground near Big Bay where it is plentiful.

Carex tincta Fernald. (*C. mirabilis tincta* Fernald). Stained Sedge.—Dry open or partially shaded ground near Big Bay. Plentiful.

Carex aenea Fernald. Fernald's Hay Sedge.—Dry open ground near Marquette. Plentiful.

Carex angustiar Mack. Narrow-fruited Sedge.—Open marshy ground near city of Marquette. Perhaps to be found throughout. This sedge has not yet appeared in the manuals.

Carex canescens L. Silvery Sedge.—Wet open places near Big Bay. Plentiful.

Carex brunnescens Poir. Brownish Sedge.—Open woods near Huron Mountain Club. Plentiful throughout.

Carex Deweyana Schwein. Dewey's Sedge.—Rich open woods near Huron Mountain Club. Plentiful throughout.

Carex trisperma Dewey. Three-fruited Sedge.—Boggy shaded ground near Huron Mountain Club. Plentiful throughout.

Carex disperma Dewey. (*C. tenella* Schkuhr.). Soft-leaved Sedge.—Damp rich woods and shaded swampy ground. Common throughout.

Carex rosea Schkuhr. Stellate Sedge.—Dry open woods near Marquette. Plentiful.

Carex vulpinoidea Michx. Fox Sedge.—Mostly damp low ground about Marquette. Plentiful.

Carex diandra Schrank. Lesser Panicled Sedge.—Open boggy ground near Huron Mountain Club. Frequent throughout.

Carex stipata Muhl. Awl-fruited Sedge.—Wet open or partially shaded places. Common throughout.

Carex Sartwellii Dewey. Sartwell's Sedge.—Wet boggy ground, often in shallow water about Marquette. Plentiful.

Carex crinita Lam. Fringed Sedge.—Rich wet shaded ground near Huron Mountain Club. Plentiful throughout.

Carex aquatilis substricta Kükenthal. Smaller Water Sedge.—Very wet open places near Huron Mountain Club and about Marquette. Plentiful.

Carex hassei Bailey. (*C. bicolor* All.) Hasse's Sedge.—Damp sandy open ground along shores near Huron Mountain Club. Frequent throughout.

Carex leptalea Wahlenb. Bristle-stalked Sedge. — Wet meadow-like ground and in boggy places near Huron Mountain Club. Abundant.

Carex polygama Schkuhr. (*C. Buxbaumii* Wahl.). Brown Sedge.—Wet marshy places near Huron Mountain Club. Frequent throughout.

Carex stricta Lam. Tussock Sedge.—Very wet open or partially shaded places near Huron Mountain Club and about Marquette. Frequent.

Carex strictior Dewey. Stiff Sedge.—Open marshy or damp meadow-like ground near Huron Mountain Club. Plentiful. This sedge has not yet appeared in the manuals.

Carex gracillima Schwein. Graceful Sedge.—Woods or any rich partially shaded ground near Huron Mountain Club. Frequent throughout.

Carex tonsa (Fernald) Bicknell. (*C. umbellata tonsa* Fernald). Deep-green Sedge.—On the upper sandy beach of Lake Superior near the Huron Mountain Club. Abundant. Grows in large mats.

Carex peckii F. C. Howe. (*C. albicans* Willd.). White-tinged Sedge.—Open woods and on rocky granitic hills near Huron Mountain Club. Plentiful throughout.

Carex communis Bailey. Fibrous-rooted Sedge. — Rich dry shaded ground near Huron Mountain Club. Plentiful throughout.

Carex pennsylvanica Lam. Pennsylvania Sedge.—Dry open sandy ground and on granitic hills near Huron Mountain Club. Plentiful throughout.

Carex pedunculata Muhl. Long-stalked Sedge.—Margin of hardwoods near Huron Mountain Club. Frequent.

Carex leptonervia Fernald. (*C. laxiflora leptonervia* Fernald.). Two-edged Sedge.—Rich open or partially shaded ground. Frequent throughout.

Carex flava L. Yellow Sedge.—Damp open places near Huron Mountain Club. Plentiful throughout.

Carex arctata Boott. Drooping Wood Sedge.—Rich shaded ground near Huron Mountain Club. Frequent throughout.

Carex scabrata Schwein. Rough Sedge.—In damp open or partially shaded ground near Huron Mountain Club. Plentiful throughout.

Carex lasiocarpa Ehrh. (*Carex filiformis* Good). Slender Sedge.—Wet meadow-like ground, boggy places and often in shallow water near Huron Mountain Club. Abundant throughout.

Carex lanuginosa Michx. Woolly Sedge. — Low meadow-like ground and wet places near Marquette. Plentiful.

Carex Pseudo-Cyperus L. Cyperus-like Sedge.—Wet open ground near Negaunee. Frequent.

Carex hystricina Muhl. (*C. hystericina* Muhl.). Porcupine Sedge.—Open wet ground and often in shallow water near Huron Mountain Club. Plentiful throughout.

Carex retrorsa Schwein. Retrorse Sedge.—Wet open or partially shaded ground near Huron Mountain Club. Plentiful throughout.

Carex lupulina Muhl. Hop Sedge.—Very wet open or shaded ground near Huron Mountain Club. Frequent throughout.

Carex intumescens Rudge. Bladder Sedge. — Damp open or partially shaded ground near Big Bay. Frequent throughout.

Carex rostrata Stokes. Beaked Sedge.—Wet swampy places, often in shallow water near Marquette. Frequent throughout.

Carex Tuckermani Dewey. Tuckerman's Sedge.—Damp rich open or partially shaded ground near Huron Mountain Club. Plentiful throughout.

ARACEAE

Arisaema triphyllum (L.) Schott. Jack-in-the-pulpit, Indian Turnip.—Damp rich shaded ground near Huron Mountain Club. Plentiful throughout.

Calla palustris L. Wild Calla.—Very wet open or partially shaded places near Marquette. Plentiful throughout.

LEMNACEAE

Lemna minor L. Lesser Duckweed.—Covering still shallow water near Big Bay. Probably frequent throughout.

ERIOCAULACEAE

Eriocaulon articulatum (Huds.) Morong. (*E. septangulare* With.). Seven-angled Pipewort.—In damp sand, mud or shallow water on margin of small lakes near Huron Mountain Club. Common throughout.

PONTEDERIACEAE

Pontederia cordata L. Pickerel Weed.—In shallow water of small lakes near Huron Mountain Club. Plentiful throughout.

JUNCACEAE

Juncus bufonius L. Toad Rush.—Damp open ground, often along damp roadsides. Abundant throughout.

Juncus tenuis Willd. Slender Rush.—Common in fields, paths and on roadsides throughout.

Juncus balticus littoralis Engelm. Baltic Rush.—On sandy shores or in damp open ground. Frequent throughout. An efficient sand binder.

Juncus effusus L. Common Rush.—Marshy open ground. Common throughout.

Juncus brachycephalus (Engelm.) Buchenau. Small-headed Rush.—Wet marshy ground near Marquette. Plentiful throughout.

Juncus brevicaudatus (Engelm.) Fernald. Narrow-panicled Rush.—Wet or muddy places near Marquette. Plentiful.

Juncus canadensis J. Gay. Canada Rush.—Open marshy places near Huron Mountain Club. Plentiful throughout.

Juncus pelocarpus Mey. Brown-fruited Rush.—Wet swampy places and in damp sand on margin of small lakes near Huron Mountain Club. Plentiful throughout.

Juncus nodosus L. Knotted Rush.—Wet sandy ground and swampy places near Marquette. Frequent throughout.

LILIACEAE

Uvularia grandiflora Sm. Large-flowered Bellwort.—Rich open woods along Salmon Trout River near Huron Mountain Club. Frequent throughout.

Allium tricoccum Ait. Wild Leek.—Hardwoods near Huron Mountain Club. Common throughout.

Hemerocallis fulva L. Common Day Lily.—Inclined to escape from cultivation and persist in cities and villages. Noticed throughout.

Asparagus officinalis L. Garden Asparagus.—Dry open sandy ground throughout. Frequent.

Clintonia borealis (Ait.) Raf. Yellow Clintonia.—Mostly in hardwoods near Huron Mountain Club. Plentiful throughout.

Smilacina racemosa (L.) Desf. (*Vagnera racemosa* L., Morong.). False Spikenard.—Moist rich shaded ground near Huron Mountain Club. Plentiful throughout.

Smilacina stellata (L.) Desf. (*Vagnera stellata* L., Morong.). Star-flowered Solomon's Seal.—Dry sandy open, or damp rich shaded ground near Huron Mountain Club. Often on sandy shores. Plentiful throughout.

Smilacina trifolia (L.) Desf. (*Vagnera trifolia* L., Morong.). Three-leaved Solomon's Seal.—Very wet or boggy open or partially shaded ground near Huron Mountain Club. Frequent throughout.

Maianthemum canadense Desf. (*Unifolium canadense* Desf., Greene.). Wild Lily of the Valley.—Rich shaded ground especially in hardwoods near Huron Mountain Club. Common throughout.

Streptopus amplexifolius (L.) DC. Clasping-leaved Twisted-stalk.—Moist shaded places especially along small streams near Huron Mountain Club. Frequent throughout.

Streptopus roseus Michx. Sessile-leaved Twisted-stalk.—A specimen in herbarum of Miss Nellie M. Fairbanks collected on Presque Isle at Marquette appears to be this species. Apparently infrequent.

Streptopus longipes Fernald. Fernald's Twisted-stalk.—In woods near Huron Mountain Club. Abundant throughout Marquette County.

Polygonatum biflorum (Walt.) Ell. Hairy Solomon's Seal.—Hardwoods near Huron Mountain Club. Plentiful throughout.

Convallaria majalis L. Lily of the Valley.—Inclined to escape from cultivation frequently and persist in cities and villages.

Trillium sessile L. Sessile-flowered Wake Robin.—In herbarium of Miss Nellie M. Fairbanks, collected on Presque Isle near city of Marquette. Apparently infrequent.

Trillium grandiflorum (Michx.) Salisb. Large-flowered Wake Robin.—Rich shaded ground especially in hardwoods. Plentiful throughout.

Trillium cernuum L. Nodding Wake Robin.—Rich shaded ground throughout. Noted in particular along Salmon Trout River near Huron Mountain Club.

IRIDACEAE

Iris versicolor L. Large Blue Flag.—Wet open or partially shaded ground near Huron Mountain Club. Not rare throughout, but not noted as abundant anywhere.

Sisyrinchium angustifolium Mill. Pointed Blue-eyed Grass.—In meadow-like open ground and often in damp sandy places about city of Marquette. Probably frequent throughout.

ORCHIDACEAE

Cypripedium parviflorum Salisb. Smaller Yellow Lady's Slipper.—Mostly in swampy or boggy places near Huron Mountain Club. Frequent throughout. Specimen in herbarium of Miss Nellie M. Fairbanks, Marquette.

Cypripedium parviflorum pubescens (Willd.) Knight. Larger Yellow Lady's Slipper.—Rich shaded ground especially in woods near Huron Mountain Club. Frequent throughout.

Cypripedium hirsutum Mill. (*C. reginae* Walt.). Showy Lady's Slipper.—In open or partially shaded swampy places about Marquette. Said to be frequent. Specimen in herbarium of Miss Nellie M. Fairbanks, Marquette.

Cypripedium acaule Ait. (*Fissipes acaulis* Ait., Small.). Stemless Lady's Slipper, Moccasin Flower.—Dry shaded places about Marquette. Frequent.

Orchis rotundifolia Banks. Small Round-leaved Orchis.—Noted in an open swampy place near Marquette by Thomas M. Danger of Port Huron, Michigan, and reported in the Michigan Flora.

Orchis spectabilis L. (*Galeorchis spectabilis* L., Rydb.). Showy Orchis.—Rich woods about Marquette, and reported as frequent. Specimen in herbarium of Miss Nellie M. Fairbanks, Marquette.

Habenaria bracteata (Willd.) R. Br. (*Coeloglossum bracteatum* Willd., Parl.). Long-bracted Orchis.—Damp shaded ground near Huron Mountain Club. Probably frequent throughout.

Habenaria flava (L.) Gray. (*Perularia flava* L., Farwell). Tubercled Orchis.—Wet open or partially shaded places near Huron Mountain Club. Probably frequent throughout.

Habenaria hyperborea (L.) R. Br. (*Limnorchis hyperborea* L., Rydb.). Tall Leafy Green Orchis.—Damp rich woods near Huron Mountain Club. Probably frequent throughout.

Habenaria dilatata (Pursh) Gray. (*Limnorchis dilatata* Pursh, Rydb.). Tall White Bog Orchis.—Damp open or partially shaded ground about Marquette. Said to be frequent throughout.

Habenaria clavellata (Michx.) Spreng. (*Gymnadeniopsis clavellata* Michx., Rydb.). Small Green Wood Orchis.—Damp or boggy open or partially shaded ground near Huron Mountain Club. Frequent throughout.

Habenaria obtusata (Pursh) Richards. (*Lysiella obtusata* Pursh, Richards). Small Northern Bog Orchis.—Swampy places and rich damp woods near Huron Mountain Club. Probably frequent throughout.

Habenaria Hookeri Torr. (*Lysias hookeriana* A. Gray, Rydb.). Hooker's Orchis.—Damp shaded ground near Sugar Loaf Mountain, a large rocky hill near Marquette. Said to be frequent throughout.

Habenaria orbiculata (Pursh) Torr. (*Lysias orbiculata* Pursh, Rydb.). Smaller Round-leaved Orchis.—Rich shaded ground especially in hardwoods near Huron Mountain Club. Probably frequent throughout.

Habenaria psycodes (L.) Sw. (*Blephariglottis psycodes* L., Rydb.). Smaller Purple-fringed Orchis.—Wet meadow-like ground and swampy places near Huron Mountain Club. Probably frequent throughout.

Pogonia ophioglossoides (L.) Ker. Rose Pogonia, Snake-mouth.—Boggy ground near Huron Mountain Club. Noted by Mrs. Wallace Radcliffe. Said to be frequent.

Arethusa bulbosa L. Arethusa, Dragon's-mouth.—Wet boggy places about the small lakes near Huron Mountain Club. Probably occasional throughout.

Spiranthes cernua (L.) Richard. (*Ibidium cernuum* L., House). Nodding Ladies' Tresses.—Summit of Huron Mountain, a large granitic hill near Huron Mountain Club. Probably frequent throughout.

Epipactis repens ophioides (Fernald) A. A. Eaton. (*Peramium ophioides* Fernald, Rydb.). Lesser Rattlesnake Plantain.—Damp hardwoods near Huron Mountain Club. Frequent throughout.

Epipactis decipiens (Hook.) Ames. (*Peramium decipiens* Hook., Piper). Menzie's Rattlesnake Plantain.—In hardwoods near Huron Mountain Club. Frequent throughout.

Listera cordata (L.) R. Br. (*Ohprys cordata* L.). Heart-leaved Twayblade, Double-leaf.—In a swampy place about Mountain Lake near Huron Mountain Club. Probably frequent throughout.

Corallorrhiza trifida Chatelain. (*C. corallorhiza* L., Karst.). Early Coral Root.—Damp shaded ground near Marquette. Probably frequent throughout. Specimen in herbarium of Miss Nellie M. Fairbanks, Marquette.

Corallorrhiza maculata Raf. Large Coral Root.—Rich woods near Huron Mountain Club. Probably frequent throughout.

Corallorrhiza striata Lindl. Striped Coral Root.—Rich shaded ground near Marquette. Occasional. Specimen in herbarium of Miss Nellie M. Fairbanks of Marquette.

SALICACEAE

Salix pentandra L. Bay-leaved Willow.—Along lake shore in Marquette. Cultivated, not escaping.

Salix lucida Muhl. Shining Willow.—Wet open ground with other willows near Huron Mountain Club. Common throughout.

Salix serissima (Bailey) Fernald. Autumn Willow.—Near Marquette. Probably frequent throughout.

Salix alba L. White Willow.—In cities and villages. Planted for ornamental purposes, apparently not escaping.

Salix alba vitellina (L.) Koch. Golden Willow.—Occasionally cultivated in cities and villages but not permanently escaping. Noted at Marquette.

Salix babylonica L. Weeping Willow.—Cultivated as an ornamental tree in cities and villages but not permanently escaping.

Salix longifolia Muhl. (*S. interior* Rowlee). Sandbar Willow.—Along banks of streams and lake shores near Huron Mountain Club. Plentiful throughout.

Salix cordata Muhl. Heart-leaved Willow.—Banks of streams and in damp open places near Huron Mountain Club. Probably frequent throughout. Leaves usually not heart-shaped.

Salix glaucophylla Bebb. Broad-leaved Willow.—Lake shores near Huron Mountain Club. Plentiful throughout in similar habitats.

Salix balsamifera Barratt. (*S. pyrifolia* Anders.). Balsam Willow.—Border of First Pine Lake in low ground with other willows near Huron Mountain Club. Probably frequent throughout. Noted by B. Gladewitz.

Salix syrticola Fernald. (*S. adenophylla* Hook.). Furry Willow.—On and near sandy beach of Lake Superior near Huron Mountain Club. Plentiful.

Salix pedicellaris Pursh. Bog Willow.—In wet boggy open places near Huron Mountain Club. Probably frequent throughout.

Salix discolor Muhl. Glaucous Willow, Pussy Willow.—Low ground or low banks of streams near Huron Mountain Club. Common throughout.

Salix petiolaris Sm. Slender Willow.—Damp open ground especially on borders of small lakes and along banks of streams near Huron Mountain Club. Common throughout.

Salix humilis Marsh. Prairie Willow.—Dry open ground near Huron Mountain Club. Plentiful throughout.

Salix rostrata Richards. (*S. Bebbiana* Sarg.). Bebb's Willow.—Dry or low damp ground especially on lake borders near Huron Mountain Club. Common throughout.

Salix candida Flügge. Hoary Willow, Sage Willow.—Marshy and boggy open ground about Marquette.

Salix pellita Anders. Satiny Willow.—Damp sandy shore of First Pine Lake near Huron Mountain Club. Probably occasional throughout. A rare willow.

Populus alba L. White Poplar.—Occasionally set out as a yard or street ornamental tree in cities and villages, but not escaping.

Populus tremuloides Michx. Common Poplar, American Aspen, Quiverleaf.—Dry or damp open ground near Huron Mountain Club. Frequent throughout but not noted as abundant anywhere.

Populus grandidentata Michx. Large-toothed Poplar, Large-toothed Aspen. — Bordering hardwoods near Huron Mountain Club. Plentiful throughout.

Populus balsamifera L. Balsam Poplar.—Occasional along the sandy beach of Lake Superior near Huron Mountain Club. Frequent throughout.

Populus deltoides Marsh. Cotton-wood. — Not native in Marquette County but a form of it is known as the Large-leaved Poplar or Carolina Poplar, often set out as a street tree in cities and villages.

Populus nigra italica Du Roi. (*P. italica* Moench.). Lombardy Poplar.—Occasionally set out in cities and villages as a street tree and often spreading by root. Introduced from Europe.

MYRICACEAE

Myrica Gale L. Sweet Gale.—A shrub from three to five feet high in damp open ground along streams but mostly bordering the small lakes near Huron Mountain Club. Abundant throughout.

Myrica asplenifolia L. (*Comptonia peregrina* L., Coulter). Sweet Fern. —A shrub one to three feet high growing in dry sandy mostly open ground near Huron Mountain Club. Frequent, often abundant throughout.

BETULACEAE

Corylus rostrata Ait. Beaked Hazelnut.—Rich open or partially shaded ground about Marquette and Big Bay. Plentiful throughout.

Ostrya virginiana (Mill.) K. Koch. Ironwood.—In hardwoods near Huron Mountain Club. Plentiful throughout.

Betula lutea Michx. f. Yellow Birch.—One of the principal trees in the extensive hardwood forests of the county. Lumbermen, woodsmen and land cruisers call the small trees with smooth bark yellow birch, the large ones with rough bark and red hard wood, red birch or cherry birch, the latter being much more valuable.

Betula alba papyrifera (Marsh.) Spach. (*B. papyrifera* Marsh.). Canoe Birch, White Birch.—With other trees near Huron Mountain Club. Frequent throughout.

Betula pumila glandulifera Regel. (*B. glandulifera* Regel, Butler). Glandular Low Birch.—Borders of tamarack-black spruce swamps near Huron Mountain Club. Frequent throughout.

Alnus crispa (Ait.) Pursh. Green Alder, Mountain Alder.—Borders of Rush Lake near Huron Mountain Club. Probably frequent throughout. This and the following species are much alike in general appearance.

Alnus mollis Fernald. Downy Green Alder.—Bordering woods near Huron Mountain Club, and near lighthouse at Marquette. Probably frequent throughout.

Alnus incana (L.) Moench. Speckled Alder.—Swamps and borders of streams near Huron Mountain Club. Common throughout.

FAGACEAE

Quercus rubra L. Red Oak.—A large forest tree sometimes 140 feet high and 7 feet in diameter, the species is dwarfed on Huron Mountain and other rocky hills near Huron Mountain Club. Seldom abundant but to be found throughout with other trees in dry or damp rich ground.

Quercus rubra ambigua (Michx. f.) Fernald. (*Q. borealis* Michx. f.). Gray Oak, Northern Red Oak.—A few trees noted northwest of Marquette were thought to be this variety. According to systematists it is very close to the preceding and cannot be distinguished from it without perfect fruit and even then it is often very doubtful. Also thought to be on Grand Island, Alger County.

URTICACEAE

Ulmus americana L. American Elm.—With other trees near Huron Mountain Club and throughout the county, along streams and in hardwoods.

Cannabis sativa L. Hemp.—Frequent about cities and villages throughout, persisting at least for a few years.

Humulus Lupulus L. Common Hop, Hops.—Common along banks of Salmon Trout River near Huron Mountain Club. Also noted on rocky bluffs at Marquette. Perhaps frequent throughout.

Urtica gracilis Ait. Slender Nettle.—Damp open or shaded ground about Marquette. Frequent throughout.

Laportea canadensis (L.) Gaud. (*Urticastrum divaricatum* L., Kuntze). Wood Nettle.—Open rich woods near Huron Mountain Club. Probably frequent throughout.

SANTALACEAE

Comandra Richardsiana Fernald. Richards' Toad-flax.—Dry open or partially shaded ground near Huron Mountain Club. Frequent throughout.

ARISTOLOCHIACEAE

Asarum canadense L. Wild Ginger.—Rich shaded ground near Marquette. In herbarium of Miss Nellie M. Fairbanks at Marquette. Said to be frequent.

POLYGONACEAE

Rumex Britannica L. Great Water Dock.—Wet and swampy open places near Huron Mountain Club. Frequent throughout.

Rumex crispus L. Yellow Dock, Curled Dock.—In fields and on roadsides as a weed. Common throughout.

Rumex mexicanus Meisn. Willow-leaved Dock. — In rich dry sandy ground about Marquette and at Big Bay. Probably frequent throughout.

Rumex obtusifolius L. Broad-leaved Dock, Bitter Dock.—In fields, pastures, on roadsides and a common weed in waste places. Plentiful throughout.

Rumex Acetosella L. Field Sorrel.—A common weed in fields and waste places.

Polygonum aviculare L., Knot Grass, Door-weed.—Common as a weed in cities and villages, especially in yards, lawns and waste places.

Polygonum erectum L. Erect Knotweed.—On roadsides and in streets of cities, villages and in waste places. Plentiful throughout.

Polygonum tenue Michx. Slender Knotweed.—Dry open ground near Marquette, and on summit of Huron Mountain near Huron Mountain Club. Probably frequent throughout.

Polygonum lapathifolium L. (*Persicaria lapathifolia* L., S. F. Gray). Pale Persicaria.—Wet open places at Marquette and Big Bay. Frequent throughout.

Polygonum amphibium L. (*Persicaria amphibia* L., S. F. Gray). Water Persicaria.—Low banks of streams and small lakes and often in shallow water where it floats like a pondweed.

Polygonum Hydropiper L. (*Persicaria hydropiper* L., Opiz.). Common Smartweed.—Moist open or partially shaded ground near Marquette and at Big Bay. Probably frequent throughout.

Polygonum acre HBK. (*Persicaria punctata* Ell., Small). Water Smartweed.—Wet open places or often in shallow water near Marquette and at Big Bay. Frequent throughout.

Polygonum Persicaria L. (*Persicaria persicaria* L., Small.). Lady's Thumb.—Open damp ground, usually a weed in cities, villages and waste places. Common throughout.

Polygonum hydropiperoides Michx. (*Persicaria hydropiperoides* Michx., Small). Mild Water Pepper.—Margin of Independence Lake and in shallow water at Big Bay. Apparently infrequent.

Polygonum sagittatum L. (*Tracaulon sagittatum* L., Small.). Arrow-leaved Tear-thumb.—Low open or partially shaded ground about Marquette. Frequent throughout.

Polygonum Convolvulus L. (*Tiniaria convolvulus* Webb & Moq.). Black Bindweed.—A weed in gardens, other cultivated grounds and waste places. Common throughout.

Polygonum cilinode Michx. (*Tiniaria cilinodis* Michx., Small). Fringed Black Bindweed.—Dry sandy ground or rocky hills near Marquette. Frequent throughout.

Fagopyrum esculentum Moench. (*F. fagopyrum* L., Karst.). Buckwheat.—Occasional in waste places of cities and villages throughout. Perhaps not a permanent escape.

Polygonella articulata (L.) Meisn. Coast Jointweed.—Dry open sandy ground near Marquette. Probably frequent throughout.

CHENOPODIACEAE

Cycloloma atriplicifolium (Spreng.) Coult. Winged Pigweed.—Sandy ground in waste places about Marquette.

Chenopodium Botrys L. Jerusalem Oak.—In waste places as a weed about cities and villages.

Chenopodium capitatum (L.) Asch. (*Blitum capitatum* L.). Strawberry Blite.—Dry open ground near Marquette. Occasional throughout.

Chenopodium glaucum L. Oak-leaved Goosefoot.—Only as a weed in gardens, streets and waste places of cities and villages throughout.

Chenopodium hybridum L. Maple-leaved Goosefoot.—Margins of woods and as a weed in and about cities and villages throughout.

Chenopodium album L. Lamb's Quarters, Pigweed.—One of our common weeds in cultivated grounds everywhere.

Atriplex patula hastata (L.) Gray. Halberd-leaved Orache.—A common weed in the waste places of cities and villages throughout.

Salsola Kali tenuifolia G. F. W. Mey. (*S. pestifer* A. Nelson). Russian Thistle.—Noted as a weed throughout in cities and villages.

AMARANTHACEAE

Amaranthus retroflexus L. Amaranth Pigweed, Green Amaranth.—A common weed of cultivated grounds and in waste places of cities and villages.

Amaranthus graecizans L. Tumble Weed.—Fields, gardens and waste places. Plentiful as a weed throughout.

Amaranthus blitoides Wats. Prostrate Amaranth.—A weed in cultivated grounds and waste places of cities and villages throughout.

CARYOPHYLLACEAE

Arenaria serpyllifolia L. Thyme-leaved Sandwort.—Dry open ground as a weed in and about cities and villages throughout.

Stellaria borealis Bigel. (*Alsine borealis* Bigel, Britton). Northern Stitchwort.—Damp open or partially shaded places near Marquette and Negaunee. Probably frequent throughout.

Stellaria media (L.) Cyrill. (*Alsine media* L.) Common Chickweed.—A common weed in gardens, lawns and waste places of cities and villages throughout.

Cerastium arvense L. Field Chickweed, Meadow Chickweed.—Cracks and crevices of granitic rocks on rocky hills near Huron Mountain Club. Probably in similar situations throughout. Plentiful.

Cerastium vulgatum L. Larger Mouse-ear Chickweed.—Fields, gardens, lawns and waste places throughout as a weed. Common.

Agrostemma Githago L. Corn Cockle, Cockle.—Noted in this county only as an occasional weed about cities and villages. Frequent in wheat-fields of lower Michigan and known as "Cockle."

Lychnis alba Mill. White Campion.—Fields and waste places as a weed. Throughout, becoming common.

Silene antirrhina L. Sleepy Catchfly.—Dry open ground about Marquette. Probably frequent throughout.

Silene noctiflora L. Night-flowering Catchfly.—Fields, gardens and waste places in and about cities and villages. Frequent throughout.

Saponaria officinalis L. Bouncing Bet.—On dry sandy ground in and about Marquette. Probably frequent throughout.

Saponaria Vaccaria L. (*Vaccaria vaccaria* L., Britton).Cow-herb, Cockle.—Occasional along railroads and in depot grounds and freight yards, Marquette, Negaunee and Ishpeming.

Dianthus barbatus L. Sweet William.—Inclined to escape from cultivation and persist near old dwellings. Noted in particular in a small clearing near Huron Mountain Club.

PORTULACACEAE

Claytonia virginica L. Spring Beauty.—Rich moist shaded grounds, usually in woods. Noted near Marquette by Miss Nellie May Fairbanks who has a specimen in her herbarium. Probably frequent throughout, but apparently less so than the following.

Claytonia caroliniana Michx. Carolina Spring Beauty.—Rich shaded ground near Huron Mountain Club. Apparently abundant throughout.

Portulaca oleracea L. Purslane, Pussley.—Gardens and waste places as a weed in and about cities and villages. Often abundant.

NYMPHAEACEAE

Nymphaea advena variegata (Engelm.) Fernald. Variegated Yellow Pond Lily.—Common in still and stagnant water near Huron Mountain Clug, and throughout. Included in *N. advenea* Soland in Briton & Brown's new illustrated manual.

[*Castalia odorata* (Ait.) Woodville & Wood. Sweet-scented White Water Lily.—In the opinion of the writer it is very doubtful whether this species exists in Marquette County. No very sweet-scented flowers have been noted. A careful examination of rootstocks will perhaps decide the question. For the present all white water lilies of the county so far as seen and examined are referred to the next species.]

Castalia tuberosa (Paine) Greene. Tuberous White Water Lily.—In small lakes and small slow streams near Huron Mountain Club. Plentiful throughout.

Brasenia Schreberi Gmel. Water Shield.—Noted in a pond or small lake near Negaunee. Probably frequent throughout.

RANUNCULACEAE

Ranunculus Flammula filiformis (Michx.) Hook. Smaller Creeping Spearwort.—Damp sandy shores of small lakes near Huron Mountain Club. Abundant.

Ranunculus sceleratus L. Celery-leaved Crowfoot.—Very wet places about Marquette, Negaunee and Ishpeming. Probably frequent throughout.

Ranunculus abortivus L. Small-flowered Crowfoot.—Rich shaded ground near Huron Mountain Club. Probably frequent throughout.

Ranunculus recurvatus Poir. Hooked Crowfoot.—Dry open or shaded ground near Huron Mountain Club. Plentiful throughout.

Ranunculus fascicularis Muhl. Early Crowfoot.—Open rocky places on Huron Mountain near Huron Mountain Club. Not noted anywhere before in Northern Peninsula by the writer.

Ranunculus septentrionalis Poir. Swamp Buttercup.—Wet shaded ground at Big Bay, and near Marquette, Negaunee and Ishpeming. Frequent throughout.

Ranunculus pennsylvanicus L. f. Bristly Crowfoot.—Wet open or partially shaded places near Huron Mountain Club. Frequent throughout.

Ranunculus acris L. Tall Buttercup.—Abundant throughout the county. Noted in particular at and near Negaunee, where it covers the sides and summits of rocky hills giving them a beautiful golden color when the plant is in bloom.

Thalictrum dasycarpum Fisch. & Lall. Tall Meadow Rue.—In rich open or shaded ground bordering woods or along streams near Huron Mountain Club. Frequent throughout.

Hepatica triloba Chaix. (*H. hepatica* L., Karst.). Round-lobed Liverleaf. — Rich shaded ground near city of Marquette. Probably frequent throughout.

Anemone canadensis L. Canada Anemone. — Rich open or partially shaded ground near Big Bay. Probably frequent throughout.

Anemone quinquefolia L. Wind-flower.—Rich shaded ground along Salmon Trout River near Huron Mountain Club. Probably frequent throughout.

Clematis virginiana L. Virginia Virgin's Bower.—Rich shaded ground especially along stream banks near Huron Mountain Club. Plentiful throughout.

Caltha palustris L. Marsh Marigold.—Wet open or shaded ground. Abundant throughout.

Coptis trifolia (L.) Salisb. Goldthread.—Damp shaded ground near Huron Mountain Club. Common throughout.

Aquilegia canadensis L. Wild Columbine.—Rocky granitic hills near Huron Mountain Club. Frequent throughout.

Actaea alba (L.) Mill. White Baneberry.—Rich shaded ground near Huron Mountain Club. Plentiful throughout.

BERBERIDACEAE

Caulophyllum thalictroides (L.) Michx. Blue Cohosh.—Rich shaded ground along Salmon Trout River near Huron Mountain Club. Perhaps frequent throughout.

PAPAVERACEAE

Sanguinaria canadensis L. Bloodroot.—Rich shaded ground along Salmon Trout River near Huron Mountain Club. Probably frequent throughout.

FUMARIACEAE

Dicentra Cucullaria (L.) Barnh. (*Bicuculla cucullaria* L., Millsp.). Dutchman's Breeches.—Abundant in shaded ground along Salmon Trout River near Huron Mountain Club. Common throughout.

Corydalis sempervirens (L.) Pers. (*Capnoides sempervirens* Borck.). Pale Corydalis.—Granitic rocky hills near Huron Mountain Club, and about Marquette. Probably common throughout.

CRUCIFERAE

Alyssum alyssoides L. Yellow Alyssum.—Dry ground in and about cities and villages. Frequent throughout.

Lepidium virginicum L. Wild Peppergrass.—A common weed in cultivated grounds, on roadsides, and in and about cities and villages.

Capsella Bursa-pastoris (L.) Medic. (*Bursa bursa-pastoris* L., Britton). Shepherd's Purse.—A common weed in cultivated grounds and in and about cities and villages.

Cakile edentula (Bigel.) Hook. American Sea Rocket.—On and near sandy beach of Lake Superior near Huron Mountain Club. Common on the sandy beaches of the Great Lakes.

Brassica arvensis (L.) Ktze. (*Sinapis arvensis* L.). Wild Mustard, Common Mustard.—A bad weed in grain fields, and frequent about cities and villages.

Sisymbrium officinale leiocarpum DC. Smooth-podded Hedge Mustard.—A common weed on roadsides and in waste places of cities and villages throughout. Included in *Erysimum officinale* L. in Britton & Brown.

Sisymbrium altissimum L. (*Norta altissima* L., Britton). Tumble Mustard.—A weed about cities and villages and along railroads throughout. Plentiful.

Erysimum cheiranthoides L. (*Cheirinia cheiranthoides* L., Link.). Wormseed Mustard.—A weed along railroads, in fields, and waste places of cities and villages. Frequent.

Radicula Nasturtium-aquaticum (L.) Britton & Rendle. (*Sisymbrium nasturtium-aquaticum* L.). True Water Cress.—Creeks and ditches about Marquette and Big Bay. Plentiful.

Radicula palustris (L.) Moench. Marsh Water Cress.—Wet open places or in shallow water near Huron Mountain Club. Frequent throughout.

Radicula Armoracia (L.) Robinson. (*Armoracia armoracia* L., Britton). Horseradish.—Noted throughout in damp open ground about and in cities and villages.

Dentaria diphylla Michx. Two-leaved Toothwort, Crinkle-root.—Rich shaded ground near Big Bay. Probably frequent throughout.

Dentario laciniata Muhl. Cut-leaved Toothwort.—Rich shaded ground along Salmon Trout River near Huron Mountain Club. Probably frequent throughout.

Cardamine parviflora L. Small-flowered Bitter Cress.—Rocky summit of Huron Mountain. Probably to be found in similar situations throughout. Noted by B. Gladewitz.

Cardamine pennsylvanica Muhl. Pennsylvania Bitter Cress.—Along Salmon Trout River near Huron Mountain Club. Apparently infrequent.

Arabis lyrata L. Lyre-leaved Rock Cress.—On sandy beaches and shores, and on rocky hills about Huron Mountain Club. Probably plentiful throughout.

Arabis brachycarpa (T. & G.) Britton. Purple Rock Cress.—On rocky summit of Huron Mountain, and on rocks about the lighthouse in Marquette. Probably in like situations throughout.

SARRACENIACEAE

Sarracenia purpurea L. Pitcher-plant.—Noted in swampy places and even on logs at Canyon Lake near Huron Mountain Club. Frequent throughout.

DROSERACEAE

Drosera rotundifolia L. Round-leaved Sundew.—Boggy ground and even on old logs at Canyon Lake near Huron Mountain Club. Probably frequent throughout.

CRASSULACEAE

Sedum purpureum Tausch. (*Sedum triphyllum* Haw., S. F. Gray). Liveforever.—Roadsides and waste places in cities and villages. Plentiful throughout.

SAXIFRAGACEAE

Saxifraga virginiensis Michx. (*Micranthes virginiensis* Michx., Small). Early Saxifrage.—Cracks and crevices of rocks on Huron Mountain near Huron Mountain Club. Abundant. Probably to be found in similar situations throughout the county. First noted by Mrs. A. L. Farwell, on June 3, 1917.

Tiarella cordifolia L. False Mitrewort.—Rich woods at Sugar Loaf Mountain near Marquette. Apparently infrequent.

Mitella nuda L. Naked Mitrewort.—Rich woods near Huron Mountain Club. Common throughout.

Chrysosplenium americanum Schwein. Golden Saxifrage.—In shaded cool wet and springy places near Huron Mountain Club. Plentiful throughout.

Ribes Cynosbati L. (*Grossularia Cynosbati* L., Mill.). Prickly Gooseberry.—Open or shaded rocky ground near Sugar Loaf Mountain. Apparently infrequent.

Ribes setosa (Lindl.) Cav. & Britt. Bristly Gooseberry.—Rich partially shaded ground along Salmon Trout River and about Mountain Lake near Huron Mountain Club. Apparently frequent. See Britton and Brown, 2 ed., Vol. 2, 240.

Ribes prostratum L'Her. (*R. glandulosum* Grauer.). Fetid Currant.—Rich shaded ground near Huron Mountain Club. Frequent throughout.

Ribes prostratum L'Her. (*R. glandulosum* Grauer.). Fetid Currant.—Abundant along Salmon Trout River near Huron Mountain Club. Probably plentiful throughout.

Ribes triste albinervium (Michx.) Fernald. Smooth-leaved Swamp Red Currant.—Along Salmon Trout River near Huron Mountain Club. Plentiful.

ROSACEAE

Physocarpus opulifolius (L.) Maxim. (*Opulaster opulifolius* L., Kuntze). Nine-bark.—Banks of streams and rocky hills near Huron Mountain Club. Plentiful throughout.

Spiraea salicifolia L. Common Meadow-sweet.—Low damp open ground near Huron Mountain Club. Frequent throughout.

Pyrus Malus L. (*Malus malus* L., Britton). Common Apple.—Noted throughout along roads, on margins of woods, and about cities and villages.

Pyrus americana (Marsh.) DC. (*Sorbus americana* Marsh.). American Mountain Ash.—Borders of hardwoods throughout. Frequent.

Amelanchier humilis Wieg. Small Juneberry.—Rocky summit of Huron Mountain near Huron Mountain Club. Apparently infrequent. See Rhodora, Vol. 14, 117, July, 1912.

Amelanchier canadensis (L.) Medic. Juneberry.—Dry ground bordering hardwoods near Huron Mountain Club. Frequent throughout.

Amelanchier laevis Wieg. Smooth-leaved Juneberry.—Dry open or partially shaded ground near Huron Mountain Club. Probably frequent throughout.

Amelanchier bartramiana (Tausch) Roemer. Oblong-fruited Juneberry.—Dry open ground near Lake Superior beach at Huron Mountain Club. Probably frequent throughout. See Rhodora, Vol. 17, 158, July, 1912.

Crataegus Oxyacantha L. English Hawthorn.—Cultivated in cities and villages throughout but not noted as escaping.

Crataegus punctata Jacq. Large-fruited Thorn.—Rich open or partially shaded ground near Marquette. Probably frequent throughout.

Crataegus pruinosa (Wendl.) C. Koch. Waxy-fruited Thorn.—Foot of bluffs in and about Marquette. Plentiful.

Fragaria virginiana Duchesne. Common Strawberry.—Common throughout in damp or dry open or partially shaded ground.

Fragaria vesca americana Porter. (*F. americana* Porter, Britton). American Wood Strawberry.—Usually in rich shaded ground. Frequent throughout.

Waldsteinia fragarioides (Michx.) Trattinick. Barren Strawberry.—Dry woods about Marquette. Specimen in herbarium of Miss Nellie M. Fairbanks, Marquette. Said to be plentiful.

Potentilla monspeliensis L. Rough Cinquefoil.—Dry open ground throughout, mostly as a weed. Plentiful.

Potentilla argentea L. Silvery Cinquefoil.—Dry barren open ground near Marquette. Probably frequent throughout.

Potentilla palustris (L.) Scop. (*Comarum palustris* L.). Marsh Cinquefoil.—Wet marshy and boggy places near Huron Mountain Club. Plentiful throughout.

Potentilla fruticosa L. (*Dasiphora fruticosa* L., Rydb.). Shrubby Cinquefoil.—Wet or dry open ground often on sandy shores near Huron Mountain Club. Probably plentiful throughout.

Potentilla tridentata Ait. (*Sibbaldiopsis tridentata* Soland, Rydb.). Three-toothed Cinquefoil.—Dry open ground and on rocky hills near Huron Mountain Club. Plentiful throughout.

Potentilla Anserina L. (*Argentina Anserina* L., Rydb.). Silver-weed. —Usually in dry open ground not far from Lake Superior shore. It is a common plant in the Great Lakes region.

Potentilla canadensis L. Common Cinquefoil.—Dry sandy open ground near Huron Mountain Club. Frequent throughout.

Geum canadense Jacq. White Avens.—Woods near Marquette. Probably frequent throughout.

Geum macrophyllum Willd. Large-leaved Avens.—Rich shaded ground at Sugar Loaf Mountain, a large rocky hill near Marquette. Probably plentiful throughout.

Geum strictum Ait. Yellow Avens.—Moist open ground near Huron Mountain Club. Common throughout.

Geum rivale L. Purple Avens.—Wet, usually partially shaded places near Marquette. Frequent throughout.

Rubus idaeus aculeatissimus (C. A. Mey.). Regel & Tiling. (*R. strigosus* Michx.). Wild Red Raspberry.—Damp or dry, open or partially shaded ground. Common and often abundant throughout.

Rubus parviflorus Nutt. White-flowering Raspberry. — Mostly open places in woods or rocky ground near Huron Mountain Club. Common and often abundant throughout.

Rubus triflorus Richards. Dwarf Red Raspberry.—Wet or damp shaded places near Huron Mountain Club. Common throughout.

Rubus allegheniensis Porter. High-bush Blackberry.—Dry open ground or in thickets. Plentiful throughout. Scientific name taken from last edition of Gray, page 489.

Rubus villosus Ait. Dewberry.—Sandy open or partially shaded ground near Huron Mountain Club. Plentiful throughout. See Gray's New Manual of Botany, 7 ed., 492.

Agrimonia striata Michx. Britton's Agrimony. — Damp rich shaded ground along small streams near Marquette. Probably frequent throughout.

Rosa acicularis Lindl. Prickly Rose.—Dry partially shaded ground near Marquette. Plentiful throughout.

Rosa blanda Ait. Meadow Rose.—Dry open or partially shaded ground and often on and near sandy shores. Common throughout.

Rosa carolina L. Swamp Rose.—Borders of swamps and streams near Huron Mountain Club. Frequent throughout.

Prunus virginiana L. (*Padus nana* Du Roi, Roemer). Choke Cherry.— In damp or dry, open or partially shaded ground near Huron Mountain Club. Common throughout.

Prunus pennsylvanica L. f. Wild Red Cherry, Bird Cherry.—Rocky hills near Huron Mountain Club. Usually grows as a tree from fifteen to twenty-five feet high, but on the summit of Huron Mountain and other

rocky hills it is a mere shrub two to three feet high, although blooming and bearing fruit abundantly.

Prunus pumila L. Sand Cherry.—Dry open or damp ground often on shores near Huron Mountain Club. Plentiful throughout.

LEGUMINOSAE

Trifolium pratense L. Red Clover. — Roadsides, fields and in open woods. Plentiful throughout. An escape from cultivation.

Trifolium repens L. White Clover.—Along roads, in pastures and open woods. Abundant throughout. Individual plants large and vigorous.

Trifolium hybridum L. Alsike Clover.—Roadsides, and in waste places of cities and villages throughout.

Melilotus officinalis (L.) Lam. Yellow Sweet Clover.—Occasional in waste places of cities and villages throughout.

Melilotus alba Desr. White Sweet Clover.—Occasional along roads and in waste places of cities and villages throughout.

Medicago sativa L. Alfalfa.—Occasional in waste places about Marquette.

Medicago lupulina L. Black Medic, Hop Clover.—Frequent in pastures, lawns, and waste places of cities and villages.

Vicia angustifolia (L.) Reichard. Smaller Common Vetch.—Along railroads, in cultivated ground and especially about cities and villages. Plentiful throughout.

Vicia angustifolia segetalis (Thuillier) Koch. Common Field Vetch.—Noted in one place on shaded ground near Huron Mountain Club. Apparently infrequent.

Vicia Cracca L. Tufted Vetch.—Along railroads near Marquette. Apparently infrequent.

Lathyrus maritimus (L.) Bigel. Beach Pea.—Common on and near sandy beach of Lake Superior. Often plentiful near Huron Mountain Club.

Lathyrus palustris L. Marsh Vetchling.—Damp open places throughout.

Lathyrus palustris linearifolius Ser.—Margins of woods and near base of rocky hills about Marquette. Probably frequent throughout.

Lathyrus ochroleucus Hook. Cream-colored Vetchling.—Rocky places about the lighthouse in Marquette. Plentiful. Probably to be found throughout.

LINACEAE

Linum usitatissimum L. Common Flax.—Occasional along railroads and about freight yards and depot grounds in cities and villages throughout.

OXALIDACEAE

Oxalis Acetosella L. Common Wood Sorrel.—In hardwoods often carpeting the ground. Abundant near Huron Mountain Club.

Oxalis corniculata L. Lady's Sorrel.—A weed in gardens, lawns and waste places of cities and villages. Scientific name taken from Gray's New Manual of Botany, 7 ed., page 534.

GERANIACEAE

Geranium Bicknellii Britton. Bicknell's Cranesbill.—Open rocky ground in and about Marquette. Probably frequent throughout.

POLYGALACEAE

Polygala paucifolia Willd. Fringed Milkwort.—Dry or rocky ground near Marquette. Specimen in herbarium of Miss Nellie M. Fairbanks, Marquette. Probably frequent throughout.

EUPHORBIACEAE

Euphorbia maculata L. (*Chamaesyce maculata* L., Small). Milk Purslane.—Waste places in Marquette. Probably frequent throughout.

Euphorbia Cyparissias L. (*Tithymalus cyparissias* L., Hill). Cypress Spurge.—More or less in and about cities and villages throughout. Usually abundant in cemeteries.

CALLITRICHACEAE

Callitriche palustris L. Vernal Water Starwort.—In shallow still water on margin of Independence Lake at Big Bay. Probably frequent throughout.

ANACARDIACEAE

Rhus glabra L. Smooth Sumach.—Rocky hills near Huron Mountain Club. Plentiful throughout.

Rhus Toxicodendron L. (*Toxicodendron radicans* L., Kuntze). Poison Ivy.—Noted more or less throughout in sandy open ground, on or near lake shores, and rocky hills.

AQUIFOLIACEAE

Ilex verticillata (L.) Gray. Winterberry, Black Alder.—In low ground throughout. Frequent.

Ilex verticillata tenuifolia (Torr.) Wats. (*I. bronxensis* Britton). Northern Winterberry.—On border of Rush Lake and rocky sides of Canyon Lake near Huron Mountain Club. Probably frequent throughout. Similar to the preceding but usually the berries are larger, not so numerous and an orange red.

Nemopanthus mucronata (L.) Trel. Mountain Holly.—Damp open or partially shaded ground near Huron Mountain Club. Probably frequent throughout.

ACERACEAE

Acer pennsylvanicum L. Striped Maple.—In hardwoods near Huron Mountain Club. Probably frequent throughout. Often called snakewood.

Acer spicatum Lam. Mountain Maple.—Moist woods and places near Huron Mountain Club. Common throughout.

Acer saccharum Marsh. Sugar Maple.—One of the important trees making up the hardwood forests in Marquette County. Often the dominant tree and usually mixed with yellow birch and others.

Acer saccharinum L. Silver Maple.—Not native in Marquette County, but apparently often planted in cities and villages as an ornamental tree.

Acer rubrum L. Red Maple.—Rich woods with other trees, and sometimes in dry sandy ground. In the latter habitat it is a shrub or small scraggy tree. Common throughout.

Acer Negundo L. Box Elder.—Not native but occasionally set out as an ornamental tree in cities and villages. Not noted as escaping.

SAPINDACEAE

Aesculus Hippocastanum L. Horse-chestnut.—Occasionally set out as an ornamental tree in cities and villages. Not escaping.

BALSAMINACEAE

Impatiens biflora Walt. Spotted Touch-me-not.—Damp rich open or shaded ground near Huron Mountain Club. Abundant throughout.

RHAMNACEAE

Rhamnus alnifolia L'Hér. Alder-leaved Buckthorn.—Damp open or partially shaded places near Marquette. Probably frequent throughout.

Ceanothus americanus L. New Jersey Tea.—Gravelly open ground near Marquette. Apparently infrequent.

VITACEAE

Psedera vitacea (Knerr) Greene. (*Parthenocissus quinquefolia* L., Planch.). Virginia Creeper, American Ivy.—Borders of hardwoods near Huron Mountain Club. Frequent throughout.

Vitis vulpina L. Riverside Grape.—Bank of Pine River at bridge near Huron Mountain Club. Not noted elsewhere. Apparently infrequent.

TILIACEAE

Tilia americana L. Basswood.—Frequent in hardwoods throughout. Trees often very large.

MALVACEAE

Malva rotundifolia L. Low Mallow.—Common as a weed in gardens and waste places of cities and villages throughout.

HYPERICACEAE

Hypericum perforatum L. Common St. John's-wort.—Dry open ground in and about Marquette. Frequent throughout.

Hypericum virginicum L. (*Triadenum virginicum* L., Raf.). Marsh St. John's-wort.—Marshy or swampy ground and often in water and on lake shores near Huron Mountain Club. Frequent throughout.

CISTACEAE

Helianthemum canadense (L.?) Michx. (*Crocanthemum canadense* L., Britton). Rockrose, Long-branched Frostweed. — Sandy usually open ground near Huron Mountain Club. Probably frequent throughout.

Hudsonia tomentosa Nutt. False Heather, Woolly Hudsonia.—On and near sandy beach of Lake Superior near Huron Mountain Club. Probably frequent throughout.

Lechea stricta Leggett. Bushy Pinweed.—Rocky ground on summit of Huron Mountain near Huron Mountain Club. Plentiful. Probably to be found throughout.

VIOLACEAE

Viola cucullata Ait. Marsh Blue Violet.—Wet open or partially shaded places near Huron Mountain Club. Common throughout.

Viola nephrophylla Greene. Northern Bog Violet.—Wet open or partially shaded places and along streams near Huron Mountain Club. Probably frequent throughout.

Viola papilionacea Pursh. Meadow Violet.—Moist open or partially shaded ground near Huron Mountain Club. Probably frequent throughout.

Viola septentrionalis Greene. Northern Blue Violet.—Partially shaded alluvial ground along Salmon Trout River near Huron Mountain Club. Abundant. Probably to be found throughout.

Viola Selkirkii Pursh. Selkirk's Violet, Great-Spurred Violet.—Damp shaded ground near Huron Mountain Club. No doubt frequent throughout.

Viola lanceolata L. Lance-leaved Violet. — Open wet boggy places, moist meadow-like ground and often in wet sand on shores near Huron Mountain Club. Frequent throughout.

Viola pallens (Banks) Brainerd. Northern White Violet.—In open or partially shaded wet, springy ground near Huron Mountain Club. Common throughout.

Viola renifolia Gray. Kidney-leaved Violet.—Rich shaded ground especially in hardwoods, near Huron Mountain Club. Common throughout.

Viola scabriuscula Schwein. (*V. eriocarpa* Schwein.) Smooth Yellow Violet.—Rich damp shaded ground especially in hardwoods near Huron Mountain Club. Frequent throughout.

Viola canadensis L. Canada Violet.—Shaded ground at Big Bay. Abundant. Probably to be found throughout.

Viola conspersa Reichenb. American Dog Violet.—Common in low shaded ground near Huron Mountain Club. Noted in particular on rocky ground about the lighthouse, Marquette. Frequent throughout.

Viola arvensis Murr. European Field Pansy, Wild Pansy.—Sandy open ground in and about city of Marquette. Plentiful. Miss Nellie M. Fairbanks.

CACTACEAE

Opuntia Rafinesquii Engelm. (*O. humifusa* Raf.). Western Prickly Pear.—On rocks at or near summit of Huron Mountain near Huron Mountain Club. Plentiful. Miss Anne Russell, Detroit, Michigan. Reported on rocky hills about city of Marquette.

THYMELAEACEAE

Dirca palustris L. Leatherwood.—Rich woods at Canyon Lake near Huron Mountain Club. Probably frequent throughout.

ELAEAGNACEAE

Shepherdia canadensis (L.) Nutt. (*Lepargyraea canadensis* L., Greene). Canadian Buffalo Berry.—Dry or rocky open ground near Huron Mountain Club. Frequent throughout.

ONAGRACEAE

Ludvigia palustris (L.) Ell. (*Isnardia palustris* L.). Marsh Purslane. —Wet places and in shallow water near Marquette and Big Bay. Plentiful.

Epilobium angustifolium L. (*Chamaenerion angustifolium* L., Scop.). Great Willow-herb, Fireweed.—In low open or partially shaded ground and often in clearings. Plentiful throughout.

Epilobium densum Raf. (*E. lineare* Muhl.). Linear-leaved Willow-herb. —Open low marshy ground near Marquette and Negaunee. Frequent.

Epilobium adenocaulon Haussk. Northern Willow-herb. — Rich damp and usually open ground near Big Bay. Probably common throughout.

Oenothera biennis L. Common Evening Primrose.—Usually in open dry and even in sandy places, especially on and near sandy beaches of Lake Superior. Frequent throughout.

Circaea alpina L. Smaller Enchanter's Night Shade.—Damp woods near Huron Mountain Club. Probably plentiful throughout.

HALORAGIDACEAE

Myriophyllum heterophyllum Michx. Various-leaved Water Milfoil.— In shallow water of Third Pine Lake, by the "Styx" near Huron Mountain Club. Probably frequent throughout.

ARALIACEAE

Aralia racemosa L. American Spikenard.—Rich shaded ground near Huron Mountain Club. Frequent throughout.

Aralia hispida Vent. Bristly Sarsaparilla.—Dry or sandy open or partially shaded ground near Marquette and Big Bay. Probably frequent throughout.

Aralia nudicaulis L. Wild Sarsaparilla.—Rich shaded ground near Huron Mountain Club. Common throughout.

Panax quinquefolium L. Ginseng.—Probably not growing wild at present in Marquette County. Should be looked for in rich woods. Cultivated at Big Bay by T. H. Carlson who is also attempting to plant it in nearby woods.

Panax trifolium L. Dwarf Gingseng, Ground-nut.—Rich woods especially rich alluvial ground along Salmon Trout River near Huron Mountain Club. Probably plentiful throughout.

UMBELLIFERAE

Sanicula marilandica L. Black Snake-root.—Rich shaded ground near Huron Mountain Club and at Big Bay. Common throughout.

Osmorhiza Claytoni (Michx.) Clarke, Britton. (*Washingtonia Clàytoni* Michx.). Woolly Sweet Cicely.—Rich shaded ground near Huron Mountain Club. Probably frequent throughout.

Cicuta bulbifera L. Bulb-bearing Water Hemlock.—Wet swampy open places near Huron Mountain Club.

Carum Carvi L. Caraway.—About dwellings, on roadsides and in waste places of cities and villages throughout. Frequent.

Sium cicutaefolium Schrank. Hemlock Water Parsnip.—Wet muddy places near Big Bay. Plentiful throughout.

Heracleum lanatum Michx. Cow Parsnip. — Damp open or shaded ground at Big Bay. Frequent throughout.

CORNACEAE

Cornus canadensis L. (*Chamaepericlymenum canadense* L., Asch. & Graebn.). Dwarf Cornel, Dwarf Dogwood.—Damp shaded ground near Huron Mountain Club. Common throughout.

Cornus circinata L'Her (*C. rugosa* Lam.). Round-leaved Dogwood.—Shaded rocky ground about Sugar Loaf Mountain near Marquette. Plentiful throughout.

Cornus Amomum Mill. Silky Cornel.—Damp ground on margin of woods near Big Bay. Probably plentiful throughout.

Cornus Baileyi Coult. & Evans. Bailey's Dogwood.—Open dry ground about Sugar Loaf Mountain near Marquette. Probably frequent throughout.

Cornus stolonifera Michx. Red-osier Dogwood.—In wet places, often in damp sand near shores. Common throughout.

Cornus paniculata L'Her. (*C. femina* Mill.). Panicled Dogwood. — Thickets, stream banks and borders of woods near Marquette. Common throughout.

Cornus alternifolia L. f. Alternate-leaved Dogwood.—Borders of woods and banks of small streams near Huron Mountain Club. Frequent throughout.

ERICACEAE

Chimaphila umbellata (L.) Nutt. Pipsissewa, Prince's Pine.—Dry woods near Huron Mountain Club. Frequent throughout.

Pyrola secunda L. One-sided Wintergreen.—Rich woods near Huron Mountain Club. Plentiful throughout.

Pyrola elliptica Nutt. Shin Leaf.—Dry shaded ground especially in dry woods near Huron Mountain Club. Probably frequent throughout.

Pyrola asarifolia Michx. Liver-leaf Wintergreen.—Damp shaded ground about Sugar Loaf Mountain near Marquette. Probably frequent throughout.

Pyrola asarifolia incarnata (Fisch.) Fernald. (*P. uliginosa* Torr.). Bog Wintergreen.—Damp or boggy ground about Sugar Loaf Mountain near Marquette. Probably frequent throughout.

Monotropa uniflora L. Indian Pipe.—Rich usually shaded ground near Huron Mountain Club. No doubt common throughout.

Ledum groenlandicum Oeder. Labrador Tea.—In boggy places and damp thickets near Huron Mountain Club. Common throughout.

Kalmia polifolia Wang. Pale Laurel.—Boggy open ground near Huron Mountain Club. Frequent throughout.

Andromeda glaucophylla Link. Bog Rosemary.—Boggy places and wet shores near Huron Mountain Club. Common throughout.

Chamaedaphne calyculata (L.) Moench. Leather-leaf.—Open boggy ground near Huron Mountain Club. Common throughout.

Epigaea repens L. Trailing Arbutus, May Flower.—Sandy ground, mostly under pines in the vicinity of the Huron Mountain Club, where it is abundant. Common throughout.

Gaultheria procumbens L. Wintergreen, Checkerberry.—Usually in dry sandy shaded ground, sometimes in sphagnum swamps. Abundant near Huron Mountain Club and common throughout.

Arctostaphylos Uva-ursi (L.) Spreng. (*Uva-ursi Uva-ursi* L., Britton). Red Bearberry, Bearberry.—Sandy shores and rocky hills near Huron Mountain Club. Plentiful throughout.

Chiogenes hispidula (L.) T. & G. Creeping Snowberry.—Damp woods and boggy ground near Huron Mountain Club. Frequent throughout.

Gaylussacia baccata (Wang.) C. Koch. Black Huckleberry.—Usually in shaded sandy ground near Huron Mountain Club. Plentiful throughout.

Vaccinium pennsylvanicum Lam. (*V. angustifolium* Ait.). Low Sweet Blueberry, Blueberry.—Dry sandy open or partially shaded ground near Huron Mountain Club. Common throughout.

Vaccinium pennsylvanicum nigrum Wood. (*V. nigrum* Wood, Britton). Low Black Blueberry.—Usually associated with the above species in small or large patches. Frequent throughout.

Vaccinium canadense Kalm. Canada Blueberry.—Dry, swampy, open or partially shaded ground near Huron Mountain Club. Common throughout. Often growing with and near the preceding.

Vaccinium membranaceum Dougl. Thin-leaved Bilberry.—Damp shaded ground near Huron Mountain Club. Apparently infrequent. In Chippewa County known as rabbit berry. Berries large black slightly acid but very palatable.

Vaccinium ovalifolium Sm. Oval-leaved Bilberry.—Rich woods near Huron Mountain Club. Apparently infrequent. Known in Chippewa County near Whitefish Point, as myrtilloid berry. Berry medium sized blue, slightly acid, but very palatable.

Vaccinium Oxycoccos L. (*Oxycoccos oxycoccos* L., MacM.). Small Cranberry.—Borders of and open places in tamarack-black spruce swamps. Probably frequent throughout.

Vaccinium macrocarpon Ait. (*Oxycoccus macrocarpus* Ait., Pursh). American Cranberry.—In boggy and swampy places throughout. Plentiful. Often cultivated.

PRIMULACEAE

Lysimachia terrestris (L.) BSP. Bulb-bearing Loosestrife. — Low marshy open ground near Huron Mountain Club. Frequent throughout.

Lysimachia Nummularia L. Moneywort.—A weed in lawns and waste places, Marquette. Probably to be found throughout. An escape from cultivation.

Lysimachia thyrsiflora L. (*Naumburgia thyrsiflora* L., Duby.). Tufted Loosestrife. — Wet swampy places, often in shallow water near Huron Mountain Club. Common throughout.

Trientalis americana (Pers.) Pursh. Star Flower.—Rich shaded ground near Huron Mountain Club. Common throughout.

OLEACEAE

Fraxinus americana L. White Ash.—Large trees along the Salmon Trout River near Huron Mountain Club, which are at present believed to be this species. No mature fruit or leaf specimens were secured. Noted June 2 and 7, 1917.

Fraxinus pennsylvanica Marsh. Red Ash.—About Rush Lake near Huron Mountain Club. Apparently infrequent.

Fraxinus pennsylvanica lanceolata (Borkh.) Sarg. Green Ash. — In damp ground or border of hardwoods and along streams near Huron Mountain Club. Frequent throughout.

Fraxinus nigra Marsh. Black Ash.—Swampy places and wet low banks of streams near Huron Mountain Club. Common throughout.

Syringa vulgaris L. Common Lilac.—Noted as escaping from cultivation and persisting in dry sandy ground in Marquette.

GENTIANACEAE

Menyanthes trifoliata L. Buckbean.—In bogs and shallow water near Huron Mountain Club. Common throughout.

APOCYNACEAE

Apocynum androsaemifolium L. Spreading Dogbane.—Dry open or partially shaded ground near Marquette. Frequent throughout.

CONVOLVULACEAE

Convolvulus sepium L. Hedge Bindweed.—Moist open places near Marquette. Apparently infrequent.

Convolvulus arvensis L. Field Bindweed.—In waste places in and about cities and villages throughout. Noted in particular at Big Bay and in Marquette.

BORAGINACEAE

Cynoglossum officinale L. Hound's Tongue.—Roadsides near Big Bay. Probably occasional throughout.

Lappula echinata Gilibert. (*L. lappula* L., Karst.). European Stickseed. —Roadsides and waste places about cities and villages as a weed throughout.

LABIATAE

Scutellaria lateriflora L. Mad-dog Skullcap.—Damp shaded ground near Marquette. Frequent throughout.

Scutellaria galericulata L. Marsh Skullcap.—Wet marshy places near Huron Mountain Club. Common throughout.

Nepeta Cataria L. Catnip.—As an ocasional weed in waste places of cities and villages throughout.

Nepeta hederacea (L.) Trevisan. (*Glecoma hederacea* L.). Ground Ivy.—A weed in lawns and waste places of cities and villages. Frequent throughout.

Prunella vulgaris L. Self-heal.—Roadsides and margins of woods near Marquette. Frequent throughout.

Galeopsis Tetrahit L. Hemp Nettle.—Roadsides, borders of woods and in waste places in and near Marquette. Probably frequent throughout.

Leonurus Cardiaca L. Motherwort.—A weed in gardens and waste places in and about cities and villages throughout.

Monarda mollis L. Pale Wild Bergamot.—Dry open ground about Sugar Loaf Mountain near Marquette. Apparently infrequent.

Hedeoma hispida Pursh. Rough Pennyroyal.—Dry open ground near Marquette. Apparently infrequent.

Lycopus uniflorus Michx. Northern Bugle Weed.—Low damp open or partially shaded ground near Marquette. Probably frequent throughout.

Lycopus americanus Muhl. Cut-leaved Water Hoarhound.—Damp open or shaded ground near Huron Mountain Club. Common throughout.

Mentha arvensis L. Corn Mint.—As a weed in waste places of cities and villages. Frequent throughout.

Mentha arvensis canadensis (L.) Briquet. (*M. canadensis* L.). American Wild Mint.—Damp open or shaded ground near Huron Mountain Club. Common throughout.

Mentha arvensis lanata Piper. Woolly Wild Mint.—Damp sandy ground at Big Bay. Plentiful. Large and vigorous. Probably frequent throughout.

SOLANACEAE

Solanum Dulcamara L. Climbing Nightshade.—Occasional in and about cities and villages throughout. Known in Europe as bittersweet.

Solanum nigrum L. Garden Nightshade, Deadly Nightshade.—Noted as a weed in gardens in cities and villages throughout.

SCROPHULARIACEAE

Verbascum Thapsus L. Common Mullein.—A weed along railroads, in pastures, fields, and about cities and villages. Common throughout.

Linaria vulgaris Hill. (*Llinaria* L., Karst.). Butter and Eggs.—A weed in gardens and waste places of cities and villages. Plentiful throughout.

Collinsia parviflora L. (*C. tenella* Pursh, Piper). Small-flowered Collinsia.—Summit of Huron Mountain in cracks and crevices of rocks. Plentiful. B. Gladewitz. A small plant and easily overlooked. Probably frequent in similar situations.

Scrophularia leporella Bicknell. Hare Figwort.—Rich open or partially shaded ground near Marquette. Probably frequent throughout.

Chelone glabra L. Snake-head, Turtle-head.—Damp usually partially shaded ground near Huron Mountain Club.

Mimulus ringens L. Square-stemmed Monkey Flower. — Wet open ground near Huron Mountain Club. Common throughout.

Veronica americana Schwein. American Brooklime.—Along brooks, in ditches and other wet places near Huron Mountain Club. Common throughout.

Veronica serpyllifolia L. Thyme-leaved Speedwell.—Damp or dry grassy open ground. Plentiful throughout.

Veronica peregrina L. Purslane Speedwell.—Noted only as a garden or street weed in Marquette and Negaunee. Plentiful.

Melampyrum lineare Lam. Narrow-leaved Cow Wheat.—Dry shaded ground near Huron Mountain Club. Frequent throughout.

LENTIBULARIACEAE

Utricularia vulgaris americana Gray. (*U. macrorhiza* Le Conte). Greater Bladderwort.—Ponds and slow streams near Huron Mountain Club. Probably frequent throughout.

Utricularia intermedia Hayne. Flat-leaved Bladderwort.—Usually in shallow water of marshy and swampy places near Huron Mountain Club. Frequent throughout.

Utricularia cornuta Michx. (*Stomoisia cornuta* Michx., Raf.). Horned Bladderwort.—Sandy shores of small lakes near Huron Mountain Club. Probably frequent throughout.

PHRYMACEAE

Phryma Leptostachya L. Lopseed.—Moist shaded ground near Turin. Apparently infrequent. Reported in the Michigan Flora.

PLANTAGINACEAE

Plantago major L. Common Plantain.—Lawns and waste places in cities and villages throughout.

Plantago Rugelii Dcne. Rugel's Plantain.—Along railroads, on roadsides, in fields and waste places of cities and villages. Plentiful throughout.

Plantago lanceolata L. English Plantain.—Occasional as a weed in fields and waste places of cities and villages throughout. Often a vicious field weed.

RUBIACEAE

Galium trifidum L. Small Bedstraw.—Wet marshy places near Huron Mountain Club. Frequent throughout.

Galium Claytoni Michx. Clayton's Bedstraw. — Damp and swampy places near Marquette. Probably frequent throughout.

Galium tinctorium L. Stiff Marsh Bedstraw.—Damp shaded ground near Huron Mountain Club. Frequent throughout.

Galium asprellum Michx. Rough Bedstraw. — Damp shaded ground mostly along streams near Huron Mountain Club. Common throughout.

Galium triflorum Michx. Sweet-scented Bedstraw.—Rich shaded ground especially in woods near Huron Mountain Club. Common throughout.

Mitchella repens L. Partridge Berry.—Dry woods near Huron Mountain Club. Common throughout.

CAPRIFOLIACEAE

Diervilla Lonicera Mill. (*D. diervilla* L., MacM.). Bush Honeysuckle. —Dry sandy open or partially shaded ground about Marquette. Common throughout.

Lonicera tatarica L. Tartarian Honeysuckle.—Rocky ground about the lighthouse at Marquette. Apparently infrequent. An escape from cultivation.

Lonicera canadensis Marsh. American Fly Honeysuckle.—In woods throughout the county. Common.

Lonicera oblongifolia (Goldie) Hook. Swamp Fly Honeysuckle.—Wet swampy ground near Huron Mountain Club. Probably frequent throughout.

Lonicera Caprifolium L. Perfoliate Honeysuckle.—Sandy or rocky ground in and about Marquette. An escape from cultivation. Miss Nellie M. Fairbanks.

Lonicera hirsuta Eat. Hairy Honeysuckle.—Damp mostly shaded ground and in rocky places near Marquette. Frequent throughout.

Lonicera dioica L. Smooth-leaved Honeysuckle.—Dry open or partially shaded ground and in rocky places near Marquette. Probably frequent throughout.

Symphoricarpos racemosus Michx. Snowberry.—Dry rocky places in and about Marquette. Probably frequent throughout.

Symphoricarpos racemosus laevigatus Fernald. Garden Snowberry.— Sandy open ground in Marquette. An escape from cultivation.

Linnaea borealis americana (Forbes) Rehder. Twin Flower.—Borders of damp woods or in rocky places near Huron Mountain Club. Common throughout.

Viburnum Opulus americanum Ait. (*V. opulus* L.). High Bush Cranberry, Cranberry Tree.—Borders of damp woods and along streams near Marquette and Big Bay. Frequent throughout.

Viburnum acerifolium L. Maple-leaved Arrow-wood.—Rocky woods about Marquette. Frequent throughout.

Viburnum Lentago L. Nannyberry.—Rich woods and banks of streams near Huron Mountain Club. Frequent throughout.

Sambucus canadensis L. Sweet Elder, Black-berried Elder.—Noted near railroad at Birch in rich open ground. Probably frequent throughout but not so plentiful as the following.

Sambucus racemosa L. Red-berried Elder.—Rich open or shaded ground near Huron Mountain Club. Common throughout.

CUCURBITACEAE

Echinocystis lobata (Michx.) T. & G. (*Micrampelis lobata* Michx., Greene). Wild Balsam-apple.—Rocky bluffs along Lake Superior in Marquette. Apparently an escape from cultivation.

CAMPANULACEAE

Campanula rotundifolia L. Harebell, Bluebell.—Sandy shores and open rocky places near Huron Mountain Club. Frequent throughout.

Campanula aparinoides Pursh. Marsh Bellflower.—Wet, grassy, open ground near Huron Mountain Club. Frequent throughout.

LOBELIACEAE

Lobelia Dortmanna L. Water Lobelia.—Shallow water of Rush Lake near Huron Mountain Club. Abundant. Perhaps to be found in other lakes of the county.

COMPOSITAE

Eupatorium purpureum L. Joe Pye Weed.—Low ground mostly on borders of woods and thickets near Marquette and Big Bay. Frequent throughout.

Eupatorium purpureum maculatum (L.) Darl. (*E. maculatum* L.). Spotted Joe Pye Weed.—Wet marshy places near Marquette and Negaunee. Frequent throughout.

Eupatorium perfoliatum L. Common Thoroughwort, Boneset.—Low usually open ground near Huron Mountain Club. Plentiful throughout.

Solidago hispida Muhl. Hairy Goldenrod.—Dry sandy open or partially shaded ground near Marquette. Common throughout.

Solidago Randii (Porter) Britton. Rand's Goldenrod.—On and near sandy beach of Lake Superior and rocky summit of Huron Mountain near Huron Mountain Club. Probably frequent throughout.

Solidago uliginosa Nutt. Bog Goldenrod.—Wet, open ground near Huron Mountain Club. Probably plentiful throughout.

Solidago canadensis L. Canada Goldenrod.—Rich open ground and in thickets near Marquette. Frequent throughout.

Solidago altissima L. Tall Goldenrod.—Rich open ground near Big Bay. Probably frequent throughout.

Solidago serotina Ait. Late Goldenrod.—Rich open ground or in thickets along Salmon Trout River near Huron Mountain Club. Frequent throughout.

Solidago graminifolia (L.) Salisb. (*Euthamia graminifolia* L., Nutt.). Flat-topped Goldenrod.—Moist open ground near Huron Mountain Club. Common throughout.

Aster macrophyllus L. Large-leaved Aster.—Rich shaded ground near Huron Mountain Club. Frequent, often abundant, throughout.

Aster laevis L. Smooth Aster.—Dry open or partially shaded ground near Marquette. Probably plentiful throughout.

Aster lateriflorus (L.) Britton. Calico Aster.—Border of woods and in thickets near Marquette. Common throughout.

Aster Tradescanti L. Tradescant's Aster.—Low open or partially shaded ground near Marquette. Common throughout.

Aster puniceus L. Red-stalk Aster.—Damp open or partially shaded ground near Marquette. Frequent throughout.

Erigeron philadelphicus L. Philadelphia Fleabane, Field Daisy.—Occasional in and about cities and villages as a weed. Often a field weed.

Erigeron annuus (L.) Pers. Sweet Scabious.—As an occasional weed only in and about cities and villages throughout.

Erigeron ramosus (Walt.) BSP. Daisy Fleabane.—Roadsides, fields, pastures and waste places throughout. Frequent.

Erigeron canadensis L. (*Leptilon canadense* L., Britton). Horseweed.—A weed throughout in fields, gardens, pastures and waste places. Often abundant.

Antennaria canadensis Greene. Canadian Cat's Foot.—Dry mostly open ground near Marquette. Probably frequent throughout.

Antennaria fallax Greene. Large-leaved Cat's Foot.—Summit of Huron Mountain, on rocky ground, near Huron Mountain Club. Frequent throughout.

Antennaria neodioica Greene. Smaller Cat's Foot.—Rich open or partially shaded ground near Huron Mountain Club. Frequent throughout.

Anaphalis margaritacea (L.) B. & H. Pearly Everlasting.—Dry open or partially shaded ground near Huron Mountain Club. Abundant throughout.

Gnaphalium decurrens Ives. Clammy Everlasting.—Fields, pastures, roadsides, usually in dry open ground throughout the county.

Gnaphalium uliginosum L. Low Cudweed.—Damp or dry open ground in fields and roadsides about Marquette and Big Bay. Frequent throughout.

Adenocaulon bicolor Hook. Adenocaulon.—Rich open woods at or near foot of Huron Mountain near Huron Mountain Club. Apparently infrequent.

Ambrosia trifida L. Great Ragweed.—Noted as a weed in Marquette and at Big Bay. Probably frequent throughout in cities and villages.

Ambrosia artemisiifolia L. (*A. elatior* L.). Common Ragweed.—A common weed of cultivated grounds, and in and about cities and villages throughout.

Ambrosia psilostachya DC. Western Ragweed.—A weed noted in waste places of Marquette, Negaunee and Ishpeming. Becoming frequent.

Rudbeckia hirta L. Yellow Daisy, Black-eyed Susan.—Dry open ground near Marquette. Probably frequent throughout.

Helianthus annuus L. Common Sunflower.—Rubbish heaps in Marquette. Perhaps not a permanent escape.

Helianthus tuberosus L. Jerusalem Artichoke.—Occasional in waste places about Marquette, Negaunee, and Ishpeming. An escape from cultivation.

Bidens frondosa L. Beggar-ticks.—Damp open ground about Marquette. Probably common throughout.

Bidens cernua L. Nodding Bur-marigold.—Wet open ground near Marquette. Probably frequent throughout.

Achillea Millefolium L. Common Yarrow.—Common as a weed in fields, pastures, on roadsides and in waste places, throughout the county.

Anthemis Cotula L. May Weed.—About farm dwellings, on roadsides, and in waste places of cities and villages throughout.

Chrysanthemum Leucanthemum pinnatifidum Lecoq & Lamotte. Ox-eye Daisy.—As a weed in fields, meadows, along railroads and on roadsides throughout. As a field weed becoming too frequent.

Tanacetum vulgare L. Common Tansy.—On roadsides and in waste places near cities and villages throughout.

Tanacetum huronense Nutt: Lake Huron Tansy.—Sandy beach of Lake Superior above Marquette. Apparently infrequent in this county.

Artemisia caudata Michx. Tall Wormwood.—Sandy beach of Lake Superior throughout. Often plentiful.

Artemisia biennis Willd. Biennial Wormwood.—Waste places in Marquette. Apparently infrequent. Introduced from the west.

Petasites palmatus (Ait.) Gray. Palmate-leaf Sweet Coltsfoot.—Damp shaded ground near Marquette. Probably frequent throughout.

Erechtites hieracifolia (L.) Raf. Fireweed.—Moist open or shaded ground near Big Bay. Probably frequent throughout.

Senecio aureus L. Golden Ragwort.—Wet open or partially shaded ground near Marquette. Probably frequent throughout.

Arctium minus Bernh. Common Burdock.—A weed well distributed and in various situations throughout the county.

Cirsium lanceolatum (L.) Hill. Common Bull Thistle.—In pastures, waste places and on roadsides. Frequent throughout.

Cirsium Pitcheri (Torr.) T. & G. Pitcher's Thistle.—Sandy beach of Lake Superior. Apparently infrequent in this county.

Cirsium discolor (Muhl.) Spreng. Field Thistle.—Rich open or partially shaded ground near Marquette. Probably frequent throughout.

Cirsium muticum Michx. Swamp Thistle.—Wet open or partially shaded ground near Marquette. Frequent throughout.

Cirsium arvense (L.) Scop. Canada Thistle.—Cultivated grounds roadsides, waste places, and along railroads. Becoming too common throughout.

Tragopogon porrifolius L. Oyster Plant.—Along railroads and in waste places of cities and villages. An escape from cultivation.

Tragopogon pratensis L. Yellow Goat's-beard.—In and about depot grounds and freight yards of cities and villages and along railroads. Apparently frequent throughout.

Taraxacum officinale Weber. (*Leontodon taraxacum* L.). Common Dandelion.—Very common in pastures and fields throughout.

Sonchus arvensis L. Field Sow Thistle.—About depot grounds and freight yards in cities and villages and along railroads. Frequent throughout.

Sonchus oleraceus L. Common Sow Thistle.—In gardens, fields and waste places as a weed. Plentiful throughout.

Sonchus asper (L.) Hill. Spiny-leaved Sow Thistle.—A weed in cultivated grounds and waste places of cities and villages. Plentiful throughout.

Lactuca scariola integrata Gren. & Godr. Entire-leaved Prickly Lettuce.—Becoming frequent in cultivated grounds and waste places of cities and villages throughout.

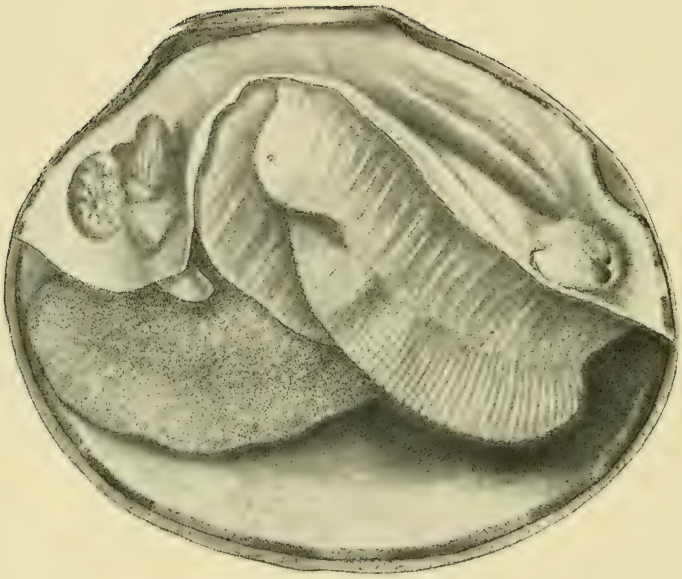
Lactuca canadensis L. Wild Lettuce. — Damp rich open or partially shaded ground near Huron Mountain Club. Plentiful throughout.

Lactuca spicata (Lam.) Hitchc. Tall Blue Lettuce.—Rich open or partially shaded ground near Huron Mountain Club. Common throughout.

Hieracium canadense Michx. Canada Hawkweed.—Dry open or partially shaded ground near Marquette. Probably frequent throughout.

Hieracium umbellatum L. (*H. scabriusculum* Schwein). Narrow-leaved Hawkweed.—Dry open or partially shaded ground near Marquette. Noted by the late Prof. C. F. Wheeler and reported in the Michigan Flora.

LAKE
SUPERIOR
HURON MOUNTAIN CLUB
CONWAY BAY
SALMON TROUT BAY
SALMON TROUT POINT
- LEGEND -
R. 28 W.
R. 27 W.



DROMUS DROMAS (LEA).

UNIVERSITY OF MICHIGAN

MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 6

A Synopsis of the Classification of the Fresh-Water Mollusca of North America, North of Mexico,

AND

A Catalogue of the More Recently Described Species, With Notes

BY

BRYANT WALKER

PART I—SYNOPSIS

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
DECEMBER 30, 1918

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The publications of the Museum of Zoology, University of Michigan, consist of two series—the Occasional Papers and the Miscellaneous Publications. Both series were founded and are being supported by Dr. Bryant Walker, Mr. Bradshaw H. Swales and Dr. W. W. Newcomb, except that the cost of the illustrations and of distribution are borne by the University.

The Occasional Papers, publication of which was begun in 1913, serve as a medium for the publication of brief original papers based principally upon the collections in the Museum. The papers are issued separately to libraries and specialists, and, when a sufficient number of pages have been printed to make a volume, a title page, table of contents and index are supplied to libraries and individuals on the mailing list for the entire series.

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

PREFACE

It has been many years since the students of the North American fresh-water mollusca have had at their service a concise and complete synopsis of the classification in general use.

The several monographs published by the Smithsonian Institution of W. G. Binney and Prime in 1865 and Tryon in 1873, together with Lea's last Synopsis in 1870, gave a very complete representation of the systematic arrangement in use at that time.

Tryon's "Monograph of the Fresh-water Mollusca of the United States," a continuation of Haldeman's Monograph of 1842, did not include the Pleuroceridæ and did not add substantially to systematic classification.

Since that time, although our knowledge on the subject has greatly increased, there have been no general monographs published covering the entire field and the recorded advances in classification are only to be found in many scattered publications not always accessible to the ordinary collector.

Certain groups have, indeed, been studied monographically. Simpson's monumental "Synopsis of the Naiades" (1900) followed by his "Descriptive Catalogue" of 1914, revolutionized the classification of that great group and pointed the way to a natural classification that has since been greatly elaborated by Ortmann in many scattered papers.

Baker's elaborate "Lymnæidæ of North and Middle America" (1911) marked another great advance in systematic classification.

Sterki's recent "Preliminary Catalog of North American Sphæriidæ" (1916) embodies the results of many years of careful study of that family and is, it is to be hoped, but the fore-runner of a complete, illustrated monograph of that most interesting, but difficult, group.

With these exceptions, the many changes in systematic nomenclature resulting from the investigations of many different workers have been published piece-meal, as it were, and in many different publications.

The need of a concise synopsis, showing the state of the science at the present time as adopted by those who are most familiar with the subject, has been met by the Museum of Zoology of the University of Michigan in its endeavors to further the study of Natural History in the schools of the state and Part I of this paper is an attempt to place before the amateur student a summary of the classification of the fresh-water mollusca which is in current use. It is to be understood, of course, that with our constantly increasing knowledge, many changes will, undoubtedly, be necessary in the future and are to be expected and hoped for. The arrangement here presented is what the compiler understands to be the state of the science at the present time.

Part II is an out-growth of a card catalogue that the writer has maintained for his own convenience for many years. In the last half century the knowledge of our fauna has enormously increased, but the many new species

have been described in many scattered publications not always accessible to the student and not to be found except by laborious and time-taking search. The convenience of a catalogue giving references to all of the new species described since the Smithsonian monographs were published is obvious.

In addition to such references, it has been deemed of service to add under many of the species, old and new, the published opinions of many writers as to their specific validity and relationships. It will be understood, of course, that such quoted opinions are not necessarily those of the compiler and are not endorsed by him unless expressly so stated. They are given solely for what they are worth as representing the views of the author at the time of their publication.

The whole subject is brought down to May 1, 1918.

BRYANT WALKER.

Dated July 1, 1918.

A SYNOPSIS OF THE CLASSIFICATION OF THE FRESH-WATER MOLLUSCA OF NORTH AMERICA, NORTH OF MEXICO.

Class ..... GASTROPODA.
Subclass ..... EUTHYNEURA.
Order ..... PULMONATA.
Suborder ..... BASOMMATOPHORA.

Superfamily LIMNOPHILA.

The North American *Limnophilæ* are in the main inhabitants of fresh water, but are occasionally found in slightly brackish water along the sea coast. The epidermis is smooth; the contractile tentacles are flattened or cylindrical; the eyes are placed on the inner bases of the tentacles. The genital orifices are separated, the male orifice is near the tentacle, the female at the base of the neck, near the respiratory orifice. The jaw is simple or composed of three pieces. The radula has numerous rows of small teeth.

Key to the families of *Limnophila*.

I. Shell spiral, dextral, spire more or less elongated.....*Lymnæidæ*.
II. Shell discoidal, with the columellar margin simple, not dilated .....*Planorbidæ*.
III. Shell spiral, sinistral .....*Physidæ*.
IV. Shell patelliform or spiral, dextral, neritoid or planorboid with the columellar margin broadly dilated.....*Ancylidæ*.

Family LYMNÆIDÆ.

Shell spiral, dextral, spire usually elongated and acute, but in some groups small and depressed.

Animal dextral. Head with a broad, short muzzle dilated at the end. Foot rounded behind. Tentacles flattened.

Jaw composed of three plates, a large one in the center, with two small, narrow laterals. Radula broad; central tooth small, simple or bicuspid, the laterals bi- or tricuspid. The marginals bi-, tri-, or multicuspid or serriform.

Genus LYMNÆA Lamarck, 1799.

Shell spiral, dextral, thin, unicolor or occasionally with longitudinal stripes; spire usually acute; aperture large, oval, rounded below, extremities united by a thin parietal callus; columella more or less twisted or plicate; lip thin, sometimes with an internal thickening or varix. Animal dextral; head large; tentacles flattened, triangular; eyes sessile on the inner bases of the tentacles.

Key to the subgenera of *Lymnæa*.

1. Spire elevated ..... 2.
   Spire short ..... 6.

2. Body-whorl greatly inflated ..... *Lymnæa s. s.*
   Body-whorl slightly inflated ..... 3.

3. Shell very slender; spire longer than the aperture; lip continuous ..... *Acella.*
   Shell more or less inflated; spire shorter than the aperture; lip not continuous ..... 4.

4. Columella smooth, reflected over the umbilicus ..... *Galba.*
   Columella twisted or plicate ..... 5.

5. Surface with impressed, spiral lines ..... *Stagnicola.*
   Surface longitudinally costate ..... *Polyrhytis.*

6. Body-whorl large, not inflated, elongate ..... *Pseudosuccinea.*
   Body-whorl large, inflated ..... 7.

7. Shell large, solid, bulimiform; lip not expanded ..... *Bulimnæa.*
   Shell moderate, spire very short, usually thin, lip more or less expanded ..... 8.

8. Shell thin, lip widely expanded, surface polished; spire acute, whorls rounded ..... *Radix.*
   Shell thicker; lip occasionally expanded; lines of growth distinct; spire broad, whorls shouldered ..... *Stagnicola* (*pars*).

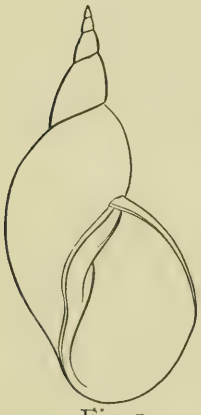


Fig. 1

Subgenus LYMNÆA s. s.

Shell large, thin, with an acute, slender spire and expanded body-whorl; axis gyrate, forming a (usually) pervious spiral coil without a true umbilicus; the callus on the body-whorl closely appressed; the outer lip flaring more or less, simple, sharp, normally without any thickening. Penis-sac very large; penis very short (about one-quarter the length of the penis-sac); penis retractors normally two, very large; anterior termination of the prostate bulb-shaped. Radula with unicuspid central and bicuspid lateral teeth, marginals serrate.

Fig. 2

Type: *L. stagnalis* L.

Example: *L. stagnalis appressa* Say, fig. 1. Radula, fig. 2.

Subgenus PSEUDOSUCCINEA Baker, 1908.

Fig. 3

Shell thin, succineiform; spire short; body-whorl large, elongated, not inflated; surface sculptured with spiral, incised lines; axis gyrate.

"Prostate long, narrowly cylindrical with a slight bulbous termination; penis thick, about half as long as penis-sac; lateral teeth bicuspid."

Fig. 5

Fig. 4

Type: *L. columella* Say, fig. 3. Radula, fig. 4. Jaw, fig. 5.

Fig. 6

Subgenus RADIX Montfort, 1810.

Shell thin, globose-oval; spire short, acute; body-whorl large, inflated; aperture very large; lip expanded.

"Prostate short, pear-shaped when viewed laterally; penis very slender, longer than penis-sac; first lateral tooth tricuspid, balance bicuspid."

Fig. 7

Type: *L. auricularia* L., fig. 6. Radula, fig. 7.

Subgenus BULIMNEA Haldeman, 1841.

Shell large and solid, bulimiform, with an impervious axis, a twisted or subplicate pillar, the callus on the body-whorl and pillar closely appressed and the outer lip not thickened or expanded.

"Prostate very large, irregularly elongate-ovate; penis very large, one-fourth longer than penis-sac, gradually enlarging in diameter toward the distal end; lateral teeth tricuspid."

Type: *L. megasoma* Say, fig. 8. Radula, fig. 9.

Fig. 9

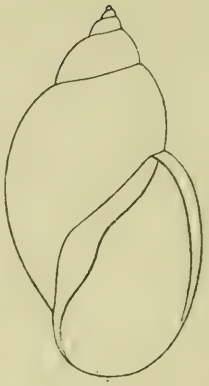


Fig. 8

Subgenus ACELLA Haldeman, 1841.

Shell thin, smooth, acute, extremely slender; aperture expanded at the margin; the inner lip not appressed, a moderate chink behind it; axis gyrate, pervious, not plicate; outer lip simple, sharp.

"Prostate large, flatly cylindrical; penis thick, about four-sevenths the length of penis-sac; lateral teeth bicuspid; the mesocone with a distinct entoconic swelling."

Type: *L. haldemani* "Desh." W. G. Binn., fig. 10. Radula, fig. 11.

Fig. 10

Fig. 11

Subgenus GALBA Schrank, 1803.

Shell small, turreted; spiral sculpture wanting or subobsolete; columella smooth; inner lip flatly reflected over the umbilicus.

"Prostate long-ovate; penis a trifle shorter than penis-sac, of narrow diameter; lateral teeth bicuspid."

Type: *L. truncatula* Müll.

Example: *L. caperata* Say, fig. 12. Radula, fig. 13.

Fig. 12

Fig. 13

Section PSEUDOGALBA Baker, 1913.

Shell as in *Galba,* but with the inner lip less expanded. Genitalia in *Galba*. Lateral teeth tricuspid.

Fig. 14

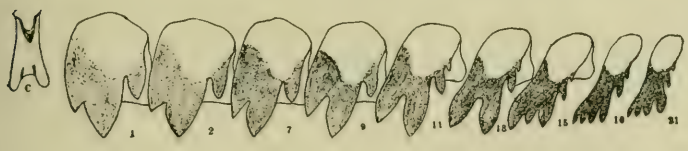


Fig. 15

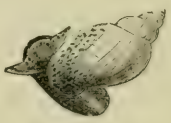


Fig. 16

Type: *L. humilis* Say, fig. 14. Radula (*L. obrussa* Say), fig. 15. Animal (ibid.), fig. 16.

Subgenus STAGNICOLA Leach, 1830.

Shell varying from elongate to short-ovate; outer lip (usually) somewhat thickened within; columella distinctly plicate; inner lip appressed; axis slightly or not all perforate; surface with strong, spirally impressed lines.

"Prostate elongate-pyriform; penis from three-fourths to four-fifths the length of penis-sac, very thick; lateral teeth bicuspid."

Type: *L. palustris* Müller, fig. 16. Radula, fig. 18.

Fig. 17

Fig. 18

Section POLYRHYTIS Meek, 1876.

Shell longitudinally costate. Soft anatomy unknown.

Type: *L. kingii* Meek.

Example: *L. utahensis* Call, fig. 19.

Fig. 19

Family PLANORBIDÆ.

Key to the subfamilies of *Planorbidæ*.

Shell discoidal ..... *Planorbinæ.*
Shell spiral ..... *Pompholiginæ.*

Subfamily PLANORBINÆ H. and A. Adams, 1858.

Shell discoidal, ultra-dextral or sinistral. Animal sinistral, having the pulmonary, genital and excretory orifices on the left side. Tentacles long, slender and cylindrical. Jaw in three segments. Radula with the numerous teeth arranged in nearly horizontal rows, central small and bicuspid, marginals tricuspid, laterals multicuspid.

In the formation of the keys and descriptions of the various subdivisions of the family, the shells are treated with reference to their apparent mode of spiral growth.

Key to the genera of *Planorbinæ*.

1. Aperture dentate within ..... *Segmentina.*
2. Aperture without internal teeth ..... *Planorbis.*

Genus PLANORBIS Müller, 1774.

Shell discoidal, dextral or sinistral, spire very much depressed, not usually rising above the margin of the body whorl; no real columella; aperture oblique; outer lip simple and sharp or thickened. Animal smooth; head short; tentacles long, slender and cylindrical; eyes sessile on the inner bases of the tentacles; foot short, narrow, obtuse at both ends; jaw and radula as in the subfamily.

Key to the subgenera of *Planorbis.*

1. Aperture simple, lip thickened ..... *Helisoma.*
   Aperture simple, lip sharp ..... 2.
   Aperture campanulate, lip thickened ..... *Planorbella.*

2. Shell sinistral ..... *Planorbis s. s.*
   Shell dextral ..... 3.

3. Base of body-whorl flattened ..... *Tropidiscus.*
   Base of body-whorl convex ..... 4.

4. Body-whorl rounded or angulated ..... *Gyraulus.*
   Body-whorl acutely carinated or lenticular ..... *Hippeutis.*

Subgenus PLANORBIS s. s.

Shell sinistral, large, with a moderate number of gradually increasing whorls, rounded above and below; aperture slightly and gradually expanded, with its margin simple and sharp.

Represented in our fauna by a single section.

Section PLANORBINA Haldeman, 1842.

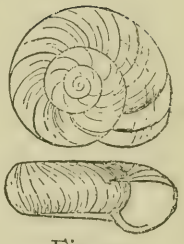


Fig. 20

Shell like *Planorbis, s. s.*, but vertically compressed, with smaller and more numerous whorls and a very oblique aperture.

Type: *P. olivaceus* Spix.

Example: *P. glabratus* Say, fig. 20.

Subgenus HELISOMA Swainson, 1840.

Shell dextral or sinistral, few whorled, the whorls carinate above and rapidly enlarging; base funicular; aperture suddenly expanding and thickened.

Key to the sections of *Helisoma.*

1. Shell dextral, carinated above and below, spire and base funicular ..... *Helisoma s. s.*
2. Shell sinistral, early whorls flattened and carinate above, base funicular .....*Pierosoma.*

Fig. 21

Section of HELISOMA s. s.

Shell dextral, moderate size, few whorled, the whorls carinated above and below and rapidly enlarging; spire and base funicular, aperture suddenly expanded, with a thickened peritreme.

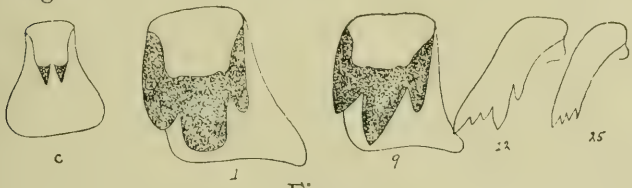


Fig. 22

Fig. 23

Type: *P. bicarinatus* Say, fig. 21. Radula, fig. 22. Animal, fig. 23.

Section PIEROSOMA Dall, 1905.

Shell sinistral, large, high, with few transversely sculptured whorls; the early whorls carinate and flattened above, funicular below; in the adult the flattened apex is usually depressed below the upper level of the body whorl; the aperture is suddenly expanded and somewhat thickened.

Fig. 24

Fig. 25

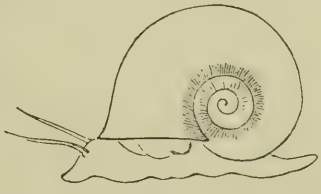


Fig. 26

Type: *P. trivolvis* Say, fig. 24. Radula, fig. 25. Animal, fig. 26.

Subgenus PLANORBELLA Haldeman, 1842.

Shell sinistral, depressed, whorls more numerous than in *Helisoma;* apex scarcely, if any, depressed below the level of the body-whorl; base funicular; body-whorl constricted behind the widely expanded, campanulate aperture.

Type: *P. campanulatus* Say, fig. 27. Radula, fig. 28.

Fig. 27

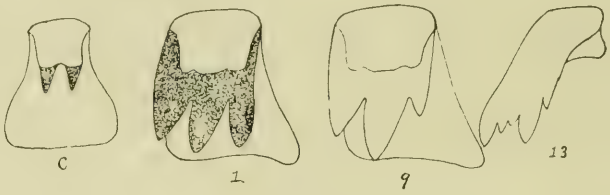
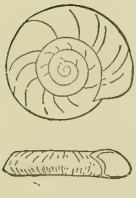


Fig. 28

Subgenus TROPIDISCUS Stein, 1850.



Shell dextral, moderately large, depressed, upper surface convex, base flattened, adult periphery angular or carinate, the aperture oblique, slightly expanded, simple.

Type: *P. umbilicatus* Müller.

Example: *P. cultratus* d'Orb., fig. 29.

Fig. 29

Subgenus HIPPEUTIS Agassiz, 1837.

Shell dextral, small, lenticular, with a small number of rapidly increasing whorls, the last enveloping a large part of the preceding whorl; apex slightly depressed, base with a narrow umbilicus, aperture oblique with a thin sharp margin.

Type: *Helix fontanus* Lightfoot.

Section MENETUS H. and A. Adams, 1855.

Like *Hippeutis,* but the last whorl not enveloping the preceding whorls to so large an extent.

Type: *P. opercularis* Gld., fig. 30.

Subgenus GYRAULUS Agassiz, 1837.

Shell dextral, small, with few, rapidly increasing whorls, fully exposed above and below, with a nearly median periphery, rounded or obtusely angulated, but not accurately carinated.

Fig. 30

Key to the sections of *Gyraulus*.

1. Surface spirally striate and hispid.....*Gyraulus s. s.*
2. Surface smooth or finely striate.....*Torquis.*
3. Surface costate .....*Armiger.*

Section GYRAULUS, s. s.

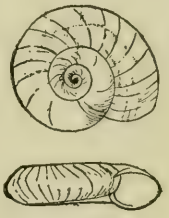


Fig. 31

Periphery rounded, or angulated, surface spirally striate and hispid; aperture simple, sharp-edged, oblique.

Type: *P. albus* Müller.

Example: *P. hirsutus* Gld., fig. 31.

Section TORQUIS Dall, 1905.

Like *Gyraulus s. s.,* but with more rounded, less rapidly increasing whorls, not hispid nor spirally striate; aperture expanded and slightly thickened in the adult.

Fig. 32

Fig. 33

Type: *P. parvus* Say, fig. 32. Radula, fig. 33.

Section ARMIGER Hartmann, 1840.

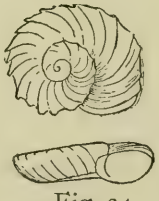


Fig. 34

Shell dextral, very small, with few rapidly increasing, costate whorls, the costæ projecting at the periphery; the form in a general way like *Gyraulus.*

Type: *P. crista* L., fig. 34.

Genus SEGMENTINA Fleming, 1817.

Shell discoidal, dextral, whorls few, rounded or carinated above and below, with one or more sets of laminæ or teeth in the interior of the shell.

Animal as in *Planorbis,* tentacles filiform; foot narrow anteriorly, wider behind, obtusely rounded at both ends. Radula, central tooth bicuspid; laterals tricuspid; marginals 4-5 cuspid.

Type: *Nautilus lacustris* Lightfoot.

Subgenus PLANORBULA Haldeman, 1842.

Shell rather small, whorls few, slowly and regularly increasing, rounded or carinated above and below; aperture somewhat expanded, lip more or less thickened within; a single persistent set of 6 dentiform lamellæ at short distance within the aperture.

Fig. 35

Fig. 36

Fig. 37

Type: *Planorbis armigerus* Say, fig. 35. Aperture, fig. 36. Radula, fig. 37.

Subfamily POMPHOLIGINÆ Dall, 1866.

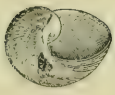
Shell spiral, dextral, flattened above; the body whorl very large.

Animal sinistral. Tentacles moderate, stout, cylindrical, slightly globose at the tips; eyes sessile, near the inner base of the tentacles; foot short, bluntly rounded behind; jaw single, subcordiform; radula with the teeth in nearly horizontal rows, central tooth small, bicuspid, laterals wide.

Key to the genera of *Pompholiginæ*.

1. Shell imperforate ..... *Pompholyx.*
2. Shell deeply umbilicate ..... *Carinifex.*

Genus POMPHOLYX Lea, 1856.



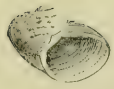


Fig. 38

Shell spiral, dextral, globosely depressed, imperforate; whorls few, spire short, obtuse; last whorl very wide, ventricose; aperture very large, wide, subcircular, expanded; lip thin; columella thickened.

Animal as in the subfamily.

Type: *P. effusa* Lea, fig. 38. Radula, fig. 39.

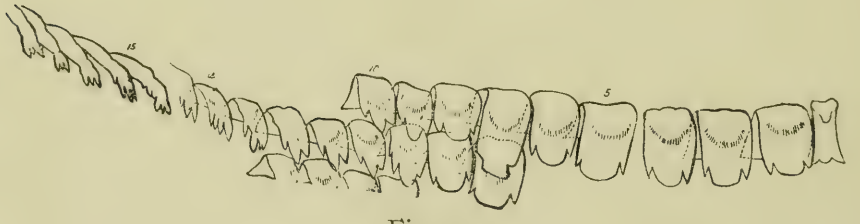


Fig. 39

Genus CARINIFEX W. G. Binney, 1863.

Shell spiral, dextral, inflated, angular; spire terraced; whorls numerous, visible above, last whorl very large, broad above, rapidly attenuated below, visible above, last whorl very large, broad above, rapidly attenuated below, umbilicus funnel shaped; aperture triangular, broad above, narrow below; inner lip slightly thickened; outer lip thin, acute, angular above, flexuose.

Fig. 40

Animal sinistral, resembling *Planorbis,* but with much shorter tentacles; jaw single; radula simliar to that of *Pompholyx.*

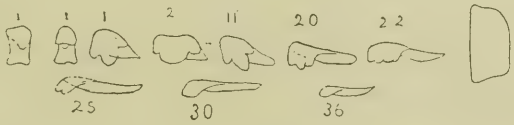


Fig. 41

Type: *Planorbis newberryi* Lea, fig. 40. Radula and jaw, fig. 41.

Family PHYSIDÆ.

Shell spiral, sinistral, thin, smooth or with microscopic transverse striae, shining, spire more or less produced.

Animal sinistral, having the pulmonary, genital and excretory orifices on the left side; tentacles slender, cylindrical; foot narrow, pointed behind; jaw single, arcuate, with a vertical fibrous accessory process on the superior margin; radula with the teeth arranged in oblique rows. Central tooth wide, base with projecting processes before and behind, multicuspid; laterals obliquely bent, comb-like, multicuspid, with a peculiar process at their external angle.

1. Shell elongate, slender, smooth, polished, inner edge of the mantle simple, not digitate, not extending beyond the shell ..... *Aplexa.*

2. Shell less elongated, body whorl usually inflated, smooth or with microscopic revolving striæ; inner edge of the mantle digitate or lobed, extending partly over the shell. . *Physa.*

Genus PHYSA Draparnaud, 1801.

Shell sinistral, oblong, thin, translucent, shining; spire acute, usually short; whorls convex; aperture ovate, rounded below; columella twisted, lip thin, acute, sometimes thickened within.

Animal as in the family, but with the inner margin of the mantle digitate or lobed, and extending over the shell.

Section PHYSA s. s.

Shell smooth.

Fig. 42

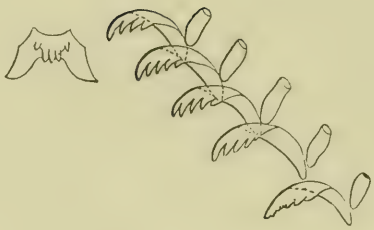


Fig. 43

Fig. 44

Type: *Bulla fontinalis* L.
Example: *P. gyrina* Say, fig. 42.
Radula: *P. humerosa* Gld., fig. 43.
Animal: *P. heterostropha* Say, fig. 44.

Fig. 45

Section COSTATELLA Dall, 1870.

Shell longitudinally costate.
Type: *P. costata* Newc., fig. 45.

Genus APLEXA Fleming, 1822.

Shell sinistral, elongated, slender, smooth, shining; spire acute; lip simple, sharp, columella but slightly twisted.

Animal similar to that of *Physa,* but with the inner edge of the mantle simple, not digitate nor reflected over on the body whorl.

Fig. 46

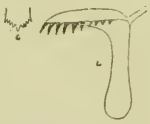


Fig. 47

Fig. 48

Type: *Bulla hypnorum* L., fig. 46. Radula, fig. 47. Animal, fig. 48.

Family ANCYLIDÆ.

Shell patelliform or dextrally spiral, neritiform or planorbiform.

Animal (fig. 49) sinistral or dextral, with a large oval foot; tentacles short, blunt, cylindrical; eyes sessile on their inner bases; jaw in three parts or the whole segmented in plates; radula with the teeth arranged in rows nearly horizontal or slightly curved, central tooth small, unicuspid or bicuspid, laterals bicuspid or comb-like, marginals comb-like or subobsolete.

Fig. 49

Key to the subfamilies of *Ancylidæ*.

1. { Shell patelliform ..... 2.
   { Shell planorbiform or neritiform.....*Neoplanorbinæ*.

2. { Shell and apex unicolored..... 3.
   { Shell small, with pink apex.....*Rhodacmeinæ*.

3. { Shell large, apex submedial.....*Lancinæ*.
   { Shell small, apex more or less posterior and excentric...*Ferrissiinæ*.

Subfamily LANCINÆ Hannibal, 1914.

Shell large for the family, ovate-elliptical, depressed or roundly arched; apex submedial, not prominent, smooth or concentrically striate. Animal with the jaw as in *Lymnæa* with two accessory plates. Radula also lymnæid in character. Central tooth unicuspid or tricuspid; laterals bicuspid with large quadrate bases; marginals comb-like, the cusps extending beyond the base.

Key to the genera of *Lancinæ*.

Shell larger, apex subcentral .....*Lanx*.
Shell smaller, apex subterminal .....*Fisherola*.

Genus LANX Clessin, 1880.

Shell large, broadly ovate, roundly arched, rather solid, apex not prominent, smooth or concentrically striate, subcentral. Radula as in the subfamily.

Type: *Ancylus newberryi* Lea, fig. 50.

Radula: *Lanx pattelloides* (Lea), fig. 51.

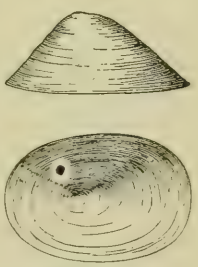


Fig. 50

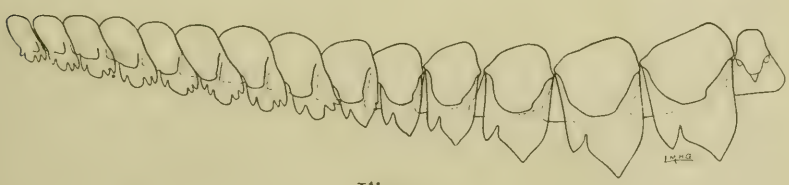


Fig. 51

Subgenus WALKEROLA Hannibal.

Shell as in *Lanx,* but thinner and more depressed.

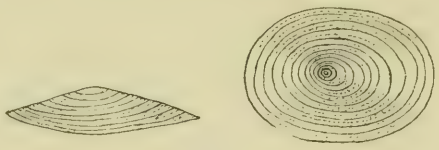


Fig. 52

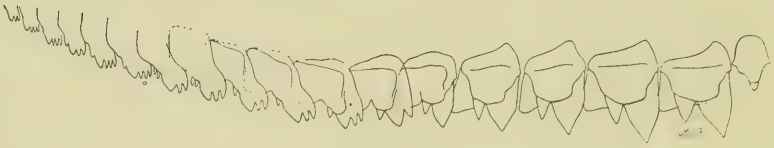


Fig. 53

Type: *Lanx klamathensis* Hann., fig. 52. Radula, fig. 53.

Genus FISHEROLA Hannibal, 1912.

Shell rounded-ovate, somewhat broader anteriorly, depressed-conic, finely concentrically striate, apex small, indistinct, subterminal, but not inclined. Anatomy unknown.

Type: *Fisherola lancides* Hann., fig. 54.

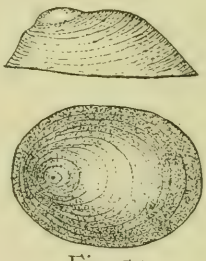


Fig. 54

Subfamily FERRISSIINÆ Walker, 1917.

Shell small, thin, broadly ovate to oblong; apex more or less posterior and eccentric, apex (in North American species) smooth or radially striate, Animal having the jaw segmented in plates. Radula with a bicuspid central, laterals obliquely reflected with from two to five small cusps, arranged like the teeth of a comb, marginals also comb-like, cusps not (usually) extending to the basal line.

Key to the genera of *Ferrissiinæ.*

Shell never septate ..... *Ferrissia.*

Shell in maturity septate ..... *Gundlachia.*

Genus FERRISSIA Walker, 1903.

Shell ovate to oblong, conic, more or less elevated, apex excentric and posterior, radially striate or smooth.

Animal as in the subfamily.

Key to the subgenera of *Ferrissia*.

Shell elevated, apex radially striate ..... *Ferrissia s. s.*
Shell depressed, apex smooth ..... *Lævapex.*

Subgenus FERRISSIA s. s.

Shell conic, elevated, apex radially striate.

Type: *Ancylus rivularis* Say, fig. 55. Radula, fig. 56.

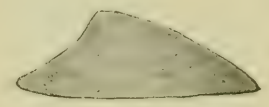


Fig. 55

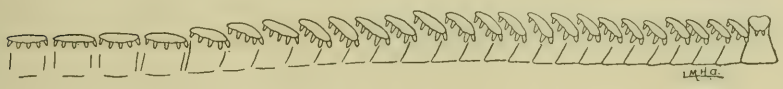


Fig. 56

Subgenus LÆVAPEX Walker, 1903.

Shell more or less depressed, apex smooth.

Type: *Ancylus fuscus* C. B. Ads., fig. 57.

Radula: *Ferrissia diaphana* (Hald.), fig. 58.

Fig. 57

Fig. 58

Genus GUNDLACHIA Pfeiffer, 1849.

Shell small, thin, ancyliform, obliquely conical; apex posterior, excentric, smooth or radially striate, inclined to the right; basal side more or less closed by a flat, horizontal septum; aperture broad-oval; margin continuous, simple, entire. Animal as in *Ferrissia*. Radula with a bicuspid central and tricuspid laterals and marginals, the cusps short and broad.

Key to the subgenera of *Gundlachia*.

Apex smooth or concentrically wrinkled ..... *Gundlachia s. s.*
Apex radially striate ..... *Kincaidella.*

Subgenus GUNDLACHIA s. s.

Apex smooth.

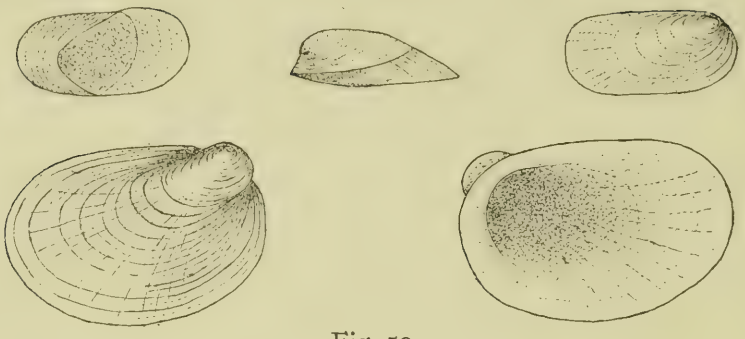


Fig. 59

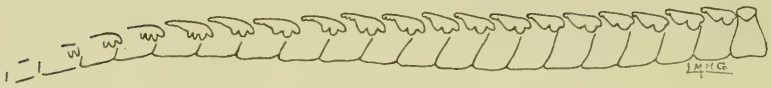


Fig. 60

Type: *Gundlachia ancyliformis* Pfr.

Example: *Gundlachia hinkleyi* Walk., fig. 59. Radula, fig. 60.

Subgenus KINCAIDELLA Hannibal, 1912.

Apex radially striate.

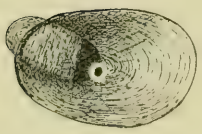


Fig. 61

Type: *Ancylus fragilis* Try. = *G. californica* Row.

Example: *G. meekiana* Stimp., fig. 61. Radula, fig. 62.

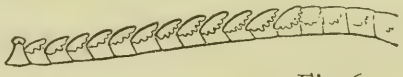


Fig. 62

Subfamily RHODACMEINÆ Walker, 1917.

Shell patelliform, conical, elevated or depressed, apex tinged with pink. Animal having the jaw composed of numerous segmented plates. Radula with a long, slender central, unicuspid or faintly bicuspid, and with the base widely expanded in some species; the first lateral very large, with an enormous mesocone, the blade-like cusp extending beyond the base, the ectocone is back of the mesocone, entirely separated from it and has several small cusps; there is no endocone; the next four laterals are similar in shape, but diminish rapidly in size towards the margin; these are succeeded by two or three transition teeth, smaller and with more or less imperfect cusps. The marginals are very small, rapidly decreasing in size towards the outer edge, with large quadrate bases wider than high, vestigial, the cusps being nearly, if not quite obsolete.

Genus RHODACMEA Walker, 1917.

Shell and animal as in the subfamily.

Key to the sections of *Rhodacmea.*

Shell elevated. Radula having the base of the central tooth expanded and not overlapped by the mesocone of the first lateral ..... *Rhodacmea s. s.*

Shell depressed. Base of central tooth of radula not expanded, overlapped by the mesocone of the first lateral....*Rhodocephala.*

Section RHODACMEA s. s.

Shell elevated. Radula with a unicuspid central, which has the base triangularly expanded; laterals with the cusp of the mesocone extending but little beyond the base and not overlapping the base of the central tooth.

Fig. 63

Type: *Ancylus filosus* Con., fig. 63. Radula, fig. 64.

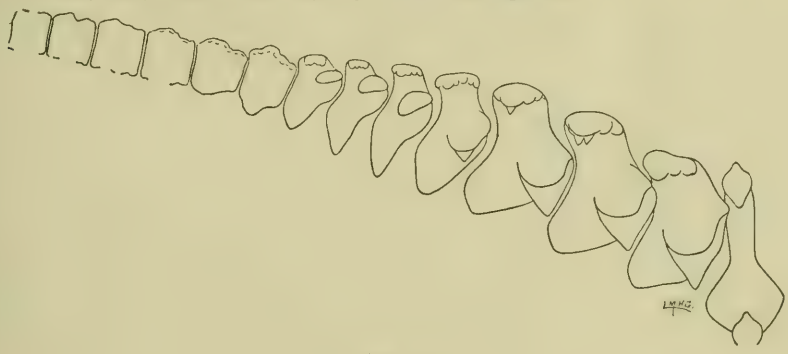


Fig. 64

Section RHODOCEPHALA Walker, 1917.

Shell depressed. Radula with a faintly bicuspid central, which has the sides of the base straight and not expanded; laterals with the cusp of the mesocone extending far beyond the base and overlapping the base of the central tooth.

Fig. 65

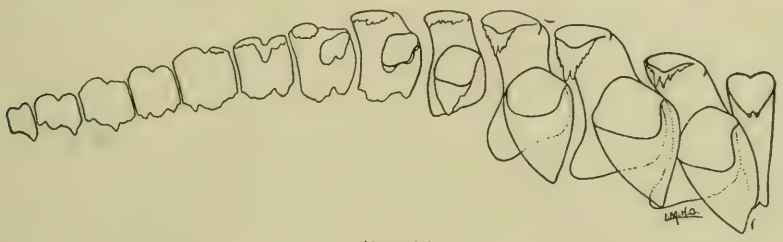


Fig. 66

Type: *Rhodacmea rhodacme* Walk., fig. 65. Radula, fig. 66.

Subfamily NEOPLANORBINÆ Hannibal, 1912.

Shell small, planorbiform or neritiform.

Key to the genera of *Neoplanorbinæ*.

Shell planorbiform ..... *Neoplanorbis.*
Shell neritiform ..... *Amphigyra.*

Genus NEOPLANORBIS Pilsbry, 1906.

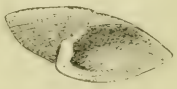


Fig. 67

Shell very minute, planorboid, dextral, subdiscoidal, nearly flat above, convex below, usually carinate at the periphery; whorls two, rapidly enlarging; aperture very oblique, wider than high, a little dilated at the base; lip thin, not continuous; columellar margin straight and broadly dilated, somewhat thickened within. Dentition and anatomy so far as known similar to *Amphigyra.*

Type: *N. tantillus* Pils., fig. 67.

Genus AMPHIGYRA Pilsbry, 1906.

Fig. 68

Shell minute, dextral, neritoid or crepiduliform, imperforate, with a small, depressed, lateral spire; whorls about 1½, very rapidly enlarging, the last very convex dorsally; apex smooth; body-whorl spirally striate; aperture very large, transversely oval; lip continuous and full, thin; cavity of the spire very small, a thin, broad, concave, columellar plate projecting across the end next the spire.

Fig. 69

Animal sinistral, externally lymnæid; tentacles short, blunt, cylindric; eyes near their inner bases; a short, false gill in the pallial cavity. Radula arranged as in *Lymnæa,* central tooth unicuspid, laterals bicuspid, marginals low, wide, with four or five cusps.

Type: *A. alabamensis* Pils., fig. 68. Radula, fig. 69.

Subclass STREPTONEURA.
Order PECTINIBRANCHIA.
Suborder TÆNIOGLOSSA.

Superfamily PLATYPODA.

Key to the families of *Platypoda*.

1. Operculum concentric ..... 2.
   Operculum spiral ..... 3.

2. Shell very large; animal with both gill and lung..... *Ampullariidæ*.
   Shell smaller; animal with gill only..... *Viviparidæ*.

3. Operculum circular, multispiral ..... *Valvatidæ*.
   Operculum paucispiral ..... 4.

4. Animal with external verge, central tooth with basal denticles ..... *Amnicolidæ*.
   Animal without verge; no basal denticles on central tooth *Pleuroceridæ*.

Family AMPULLARIIDÆ.

Shell large, spiral, globosely turbinate; aperture entire; operculum (in the North American species) corneus, concentric, with a sub-central nucleus.

Animal with snout divided into two long, tentacular lobes; tentacles long and filiform; eyes on peduncles on the outer bases of the tentacles; mantle with two cervical lobes, that on the left forming a more or less elongated siphon; genital orifices on the right side in the pallial cavity; the respiratory chamber divided into two parts, the one being a lung and the other containing a large gill; foot large, simple; jaws two; radula with seven rows of teeth, central large, subtrapezoidal, multicuspid, no basal denticles; the laterals and marginal narrow, uni- or bicuspid. Oviparous.

Genus AMPULLARIA Lamarck, 1799.

Shell dextral, globose, with a green or brown epidermis; spire short, last whorl rounded, inflated; umbilicate; aperture entire, angular above, rounded below, lip simple.

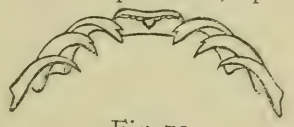


Fig. 71

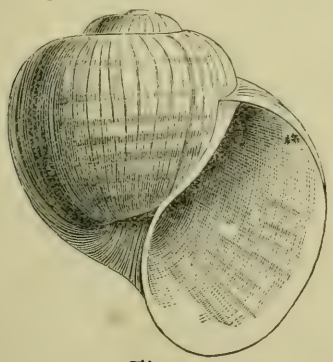


Fig. 70

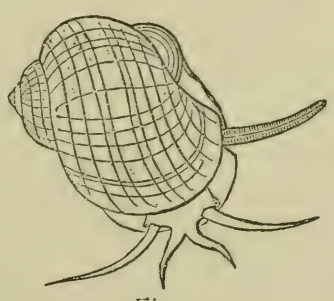


Fig. 72

Type: *Nerita urceus* Müll.

Example: *A. paludosa* Say, fig. 70. Radula, fig. 71. Animal, fig. 72.

Family VIVIPARIDÆ.

Shell moderately large, turbinate, imperforate, or subperforate; whorls convex; aperture entire, subcircular or somewhat angled above; lip simple; operculum convex, concentric, nucleus subcentral, sometimes subspiral.

Animal with a long snout, not divided into tentacular lobes; tentacles long and slender, in the male the right one is shorter, truncated and forms a sheath for the verge; eyes on peduncles on the exterior base of the tentacles; mantle with two cervical lobes, of which the right is the larger, forming with the mantle distinct tubular conduits for the ingress and egress of water for respiration; jaws two; radula with the teeth simple or denticulate, central tooth large, broad, without basal denticles, laterals large, subtrigonal, marginals narrow, elongated. Ovoviviparous.

Key to the Genera of *Viviparidæ*.

1. Operculum wholly concentric ..... 2.
   Operculum with subspiral nucleus..... *Lioplax.*

2. Reflected apices of the lateral teeth simple..... *Campeloma.*
   Reflected apices of the lateral teeth denticulate..... 3.

3. Inner margin of the operculum simple..... *Viviparus.*
   Inner margin of the operculum reflected, forming an elevated marginal fold ..... *Tulotoma.*

Genus VIVIPARUS Montfort, 1810.

Shell dextral, spiral, subconoidal; rather thin, smooth, imperforate or slightly umbilicate; light green or olivaceous, unicolored or banded with brown or tinged with purple; whorls convex, aperture entire, subcircular; lip simple, acute; columellar and parietal margin not usually thickened; operculum concentric, inner margin simple, not reflected.

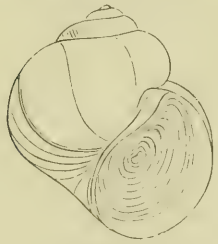


Fig. 73

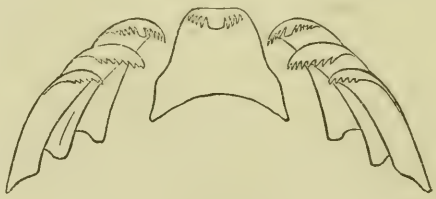


Fig. 74

Animal with foot of moderate size, not produced beyond the snout. Teeth of the radula multicuspid.

Type: *Helix vivipara* L.

Example: *V. intertextus* (Say), fig. 73. Radula, fig. 74.

Genus CAMPELOMA Rafinesque, 1819.

Shell dextral, spiral, imperforate, thick and solid; olivaceous green, unicolored, spire produced; whorls smooth, rounded or shouldered; aperture oval; lip simple, columella and parietal wall usually callously thickened. Operculum concentric, inner margin simple.

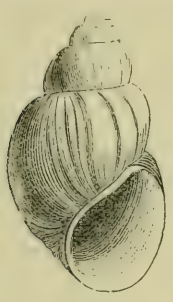


Fig. 75

Fig. 76

Fig. 77

Fig 78

Animal with the foot large, rather thin, much produced beyond the snout; snout small; teeth of the radula simple or only very minutely crenulated.

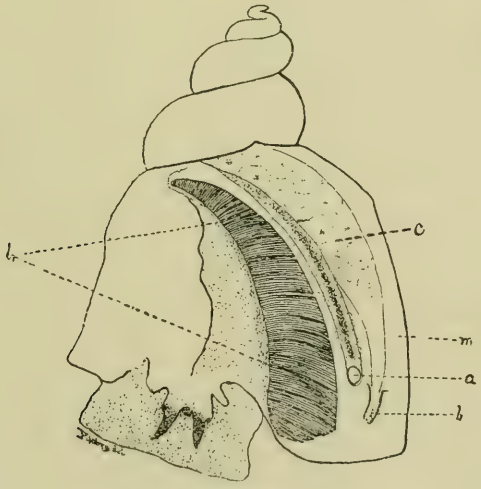


Fig 78A

a.—Anus. b-c.—Uterus.
br.—Gill. m.—Mantle.

Type: *C. crassula* Raf.

Example: *C. decisum* (Say), fig. 75. Animal, fig. 76. Operculum, fig. 77.

Radula: *C. integrum* (Say), fig. 78.

Animal: *C. subsolidum* (Anth.), fig. 78A.

Genus LIOPLAX Troschel, 1856.

Shell dextral, spiral, thin, ovate, turreted, imperforate, spire produced; whorls rounded, or carinated; olivaceous green or dark brown; aperture oval subcircular; lip thin, continuous; operculum concentric, with a subspiral nucleus.

Fig. 79

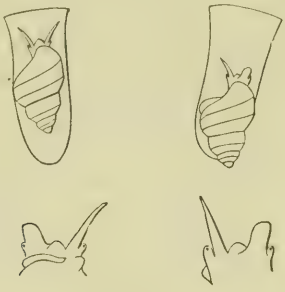


Fig. 80

Fig. 81

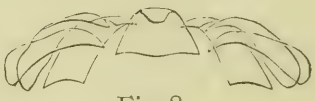


Fig. 82

Animal with the foot very large, greatly produced beyond the snout; snout very short. Lingual teeth smooth at their apices.

Type: *Limnæa subcarinata* Say, fig. 79. Animal, fig. 80. Operculum, fig. 81. Radula, fig. 82.

Genus TULOTOMA Haldeman, 1840.

Shell (typically) large, solid, thick, imperforate, obtusely conic, spire elevated; whorls flattened, nodulous, carinated; peristome thin, continuous; operculum concentric, subtriangular, with the inner margin reflected forming an elevated marginal fold.

Animal with a moderate foot, not produced beyond the snout; snout small; lingual teeth multicuspid.

Type: *Paludina magnifica* Con., fig. 83. Radula, fig. 84. Operculum, fig. 85.

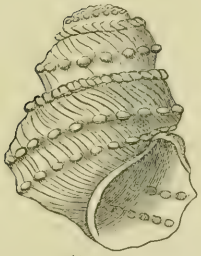


Fig. 83

Fig. 84

Fig. 85

Family VALVATIDÆ.

Shell small, spiral, dextral, turbinate, or subdiscoidal; whorls rounded or carinated; aperture entire, circular; lip simple, sharp; operculum orbicular, multispiral, whorls with a thin elevated edge.

Animal dicœcious; tentacles long, slender, cylindrical; eyes sessile on the internal bases of the tentacles; snout long; foot large, bilobed in front; gill external, plumose, protected by a long, slender pallial appendage; verge exterior, placed on the right side, at the base of and below the tentacle; jaws two; lingual teeth multicuspid, no basal denticles on the central tooth.

Genus VALVATA Müller, 1774.

The characters of the genus are those of family.

Type: *V. cristata* Müll.

Example: *V. tricarinata* (Say), fig. 86. Animal, fig. 87. Radula, fig. 88.

Fig. 86

Fig. 87

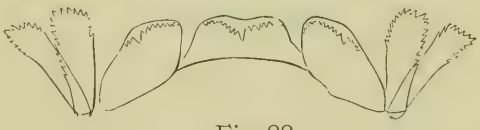


Fig. 88

Family AMNICOLIDÆ.

Shell small, spiral, dextral, conical, imperforate or umbilicated; unicolored; aperture entire, lip simple, acute; operculum concentric, spiral or subspiral.

Animal with a long snout; tentacles long, cylindrical, with the eyes at their outer bases; foot oblong, truncate before, rounded behind; gills internal; verge exserted, placed on the back, some distance behind the right tentacles; jaws two; central tooth of the radula multicuspid and with one or more basal denticles; laterals hatchet-shaped, multicuspid; marginals slender, multicuspid.

Key to subfamilies of *Amnicolidæ*.

1. Operculum multispiral ..... *Lyogyrinæ*.
   Operculum concentric ..... *Bythininæ*.
   Operculum paucispiral ..... 2.

2. Foot divided ..... *Pomatiopsinæ*.
   Foot simple ..... 3.

3. Shell thin, subglobose to elongate; columella not thickened ..... *Amnicolinæ*.
   Shell thick, short, body-whorl very large; columella thickened ..... *Lithoglyphinæ*.

Subfamily BYTHININÆ Stimson, 1865.

Shell small, spiral, dextral, turbinate, spire produced; operculum calcareous, concentric.

Foot simple; central tooth of the radula with several basal denticles.

Genus BYTHINIA Leach, 1818.

Shell large for the family, spiral, elevated, subperforate; aperture oval; peristome thin, continuous; lip simple, sharp; operculum calcereous, concentric.

Type: *Helix tentaculata* L., fig. 89. Animal, fig. 90. Radula, fig. 91.

Fig. 89

Fig. 90

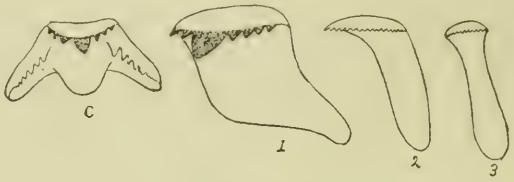


Fig. 91

Subfamily AMNICOLINÆ Gill, 1871.

Shell small, spiral, dextral, subglobose to elongate, thin; imperforate or umbilicate; columella and parietal wall not callously thickened; operculum corneous, paucispiral.

Foot simple; central tooth of the radula with several denticles.

Key to genera of *Amnicolinæ*.

1. Shell smooth, periphery rounded ..... 2.
   Shell smooth, periphery angulate ..... *Littoridina.*
   Shell strongly carinated ..... *Pyrgulopsis.*
   Shell spinose ..... *Potamopyrgus.*
   Shell longitudinally ribbed ..... *Tryonia.*

2. Shell slender, spire long ..... *Paludestrina.*
   Shell ventricose, spire usually short ..... *Amnicola.*

Genus AMNICOLA Gould and Haldeman, 1841.

Shell small, oval-conic, rather short, spire subacute; whorls 4-6, convex; aperture oval; peritreme continuous; lip simple, sharp; columella not thickened. Operculum thin, corneous, paucispiral.

Fig. 92

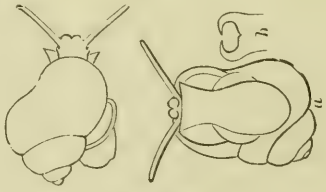


Fig. 93

Fig. 94

Animal oviparous; central tooth of the radula multicuspid, with a tooth-shaped process from the middle of the anterior surface, reaching beyond the

base, and with several basal denticles; laterals and marginals multicuspid. Verge short, bifid, with a globular base.

Type: *Paludina limosa* Say, fig. 92. Animal, fig. 93. Operculum, fig. 94. Radula, fig. 95.

Fig. 95

Subgenus CINCINNATIA Pilsbry, 1891.

Fig. 96

Radula more minute and the denticulations of the cusps finer and sharper.

Type: *Paludina cincinnatiensis* Anth., fig. 96. Radula, fig. 97.

Fig. 97

Genus PALUDESTRINA d'Orbigny, 1840.

Shell similar to *Amnicola,* but more slender and elongated. Central tooth with but one basal denticle on each side, and without the tongue shaped process of *Amnicola*. Verge bifid.

Fig. 98

Fig. 99

Type: *Cyclostoma acutum* Drap.

Example: *P. nickliniana* (Lea), fig. 98. Radula, fig. 99.

Genus TRYONIA Stimpson, 1865.

Shell perforate, elongated, turreted, subulate; apex acute; surface longitudinally ribbed or plicated; whorls numerous, shouldered; aperture small, oblique, rhombo-ovate, lip sharp, thin and effuse at the base; peritreme continuous.

Type: *T. clathrata* Stimp., fig. 100.

Fig. 100

Genus PYRGULOPSIS Call and Pilsbry, 1886.

Shell ovate-conical or turreted, imperforate, whorls having a single, strong carina at the periphery, which may or may not be concealed on the spire; apex acute; whorls 4½ to 6; aperture ovate, peristome continuous;

central tooth of the radula with but one basal denticle on each side; denticles of the lateral teeth large and angular, those of the laterals small and slender.

Fig. 101

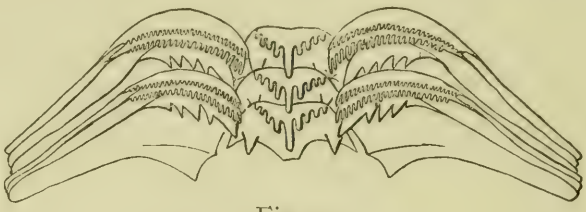


Fig. 102

Type: *Pyrgula nevadensis* Stearns, fig. 101. Radula, fig. 102.

Genus POTAMOPYRGUS Stimpson, 1865.

Fig. 103

Shell ovate-conic, imperforate; apex acute; whorls angulated and usually coronated with spines; body-whorl two-thirds the length of the shell; aperture ovate, lip acute.

Animal with rostrum of moderate length; tentacles very long, slender, tapering and pointed; eyes on prominent tubercles; foot rather short, strongly auriculated in front; central tooth of radula trapezoidal, inferior margin nearly straight; faintly enlobate; basal teeth minute and close to the lateral margin; denticles of the intermediate tooth numerous and of equal size.

Type: *Melania corolla* Gld.

Example: *P. coronatus* (Pfr.), fig. 103.

Genus LITTORIDINA Souleyet, 1852.

Shell narrowly perforate, subpyramidal, solid, opaque, body-whorl subangulate at the periphery; aperture pyriform, acutely angulated above; columella thickened, white; peritreme not continuous, lip sharp.

Verge very large, with five or six small, digitate appendices. Radula as in *Amnicola*.

Fig. 104

Fig. 105

Type: *L. gaudichaudii* Soul.

Example: *L. monroensis* (Frfld.), fig. 104. Radula, (*L. hatcheri* Pils.), fig. 105.

Subfamily LITHOGLYPHINÆ Fischer, 1885.

Shell small, spiral, dextral, spire short, body-whorl large, forming most of the shell; columella usually callously thickened; operculum corneous, subspiral.

Foot simple; central tooth of the radula with several basal denticles.

Key to the genera of *Lithoglyphinæ*.

1. Shell imperforate or narrowly perforate ..... 2.
   Shell widely umbilicate ..... 3.

2. Peritreme sinuous, lip effuse below, verge winged ..... *Fluminicola*.
   Peritreme continuous in same plane, verge simple ..... *Gillia*.
   Peritreme very oblique, lip effuse above, verge bifid .... *Somatogyrus*.

3. Shell spirally striate, depressed, turbinate, widely umbilicate ..... *Cochliopa*.
   Shell smooth, globose-turbinate, umbilicus narrower, but deep. *Clappia*.

Genus COCHLIOPA Stimpson, 1865.

Fig. 106

Shell depressed-conic; base concave, umbilicus large and deep; aperture oblique; operculum corneous, subspiral.

Rostrum of moderate size; tentacles rather long and tapering. Teeth of the radula multicuspid, basal denticles on central tooth 2 or 3 on each side. Verge rather elongated, compressed, geniculated and bifid.

Type: *Amnicola rowellii* Tryon.
Example: *C. riograndensis* P. and F., fig. 106.

Genus CLAPPIA Walker, 1909.

Fig. 107

Shell minute, spiral, dextral, globose-turbinate, narrowly but deeply umbilicate. Spire short; body whorl large; whorls round; aperture large; lip simple; columellar lip thin, appressed to the body-whorl only at the upper end; operculum paucispiral, nuclear whorls large, slowly and regularly increasing.

Fig. 108

Rachidian tooth as in *Somatogyrus*, intermediate tooth with a long peduncle and a strong tooth projecting from the infero-anterior angle, laterals multicuspid.

Fig. 109

Type: *C. clappii* Walker, fig. 107. Operculum, fig. 108. Radula, fig. 109.

Genus FLUMINICOLA Stimpson, 1865.

Fig. 110

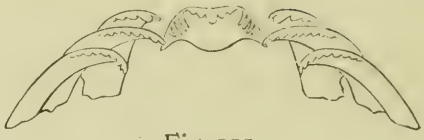


Fig. 111

Shell spiral, dextral, obliquely ovate, thick, solid, smooth, imperforate; spire moderate, obtuse; aperture ovate; columella flattened, calloused; lip effuse and projecting anteriorly so that the peritreme is not continuously in the same plane; operculum corneous, subspiral.

Rostrum rather large; tentacles tapering, foot broad; central tooth of the radula with several basal denticles on each side; outer lateral teeth with a smaller number of denticles than the inner. Verge large, compressed, with a broad semicircular wing on the left side.

Type: *Paludina nuttalliana* Lea, fig. 110. Radula, fig. 111.

Genus SOMATOGYRUS Gill, 1863.

Shell dextral, spiral, usually rather thick and solid, smooth, imperforate or narrowly perforate; spire usually short; apical whorl spirally punctate or lirate; body-whorl large, more or less inflated; aperture very oblique; lip sharp, projecting above; columella callously thickened. Operculum corneous, subspiral, nuclear whorls small, rapidly increasing.

Fig. 112

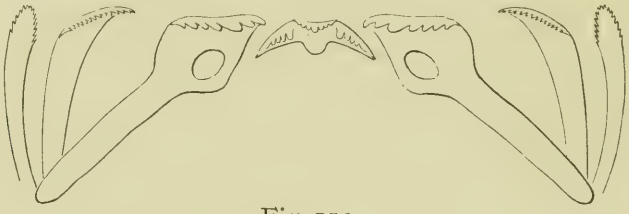


Fig. 113

Fig. 114

Rostrum rather broad, flat and square-cut; tentacles rather short and flattened; teeth of the radula multicuspid, basal denticles on the central tooth 3-4 on each side. Verge broad, compressed and bifid.

Type: *Amnicola depressa* Tryon, fig. 112. Radula, fig. 113. Operculum, fig. 114.

Genus GILLIA Stimpson, 1865.

Fig. 115

Fig. 116

Shell spiral, dextral, not very thick, smooth, imperforate; spire short, obtuse, body whorl large, inflated; aperture large, oblique; peritreme continuous on the same plane, lip thin, sharp; columella very slightly thickened; operculum corneous, subspiral.

Rostrum broad, subtruncate, foot oblong, rounded behind and auriculate

in front; tentacles long, slender and pointed; teeth of the radula multicuspid; central tooth with two basal denticles on each side. Verge small, simple, lunate.

Type: *Melania altilis* Lea, fig. 115. Radula, fig. 116.

Subfamily LYOGYRINÆ Pilsbry, 1916.

Shell minute, conical or subdepressed. Operculum circular, multispiral.

Key to the genera of *Lyogyrinæ*.

Shell amnicoliform ..... *Lyogyrus.*
Shell valvatæform ..... (s. g.) *Hauffenia.*

Genus LYOGYRUS Gill, 1863.

Fig. 117

Shell very small, spiral, dextral, smooth, umbilicate; globose-turbinate or elongate-ovate; aperture nearly circular; peritreme continuous, frequently quite separated from the body-whorl. Operculum corneous, circular, multispiral.

Rostrum bilobed in front, half as long as the tentacles, which are rather stout; foot auriculated in front; gill external. Dentition as in *Paludestrina*, basal denticles on rachidian tooth two on each side.

Type: *Valvata pupoidea* Gld., fig. 117.

Genus HORATIA Bourguignat, 1887.

Shell very small, amnicoliform, thick-shelled, umbilicate, almost smooth; whorls only 3-4, convex, rapidly increasing, the last large, rounded; suture impressed; aperture very oblique, rounded; lip adherent, straight, sharp; columella thickened, incurved. Operculum corneous, transparent, purple-red, with 3-4 slowly increasing spirals and an almost central nucleus.

Type: (first species) *Horatia klecakiana* Bgt.

Fig. 118

Subgenus HAUFFENIA Pollonera, 1898.

Shell minute, rather thin, valvatæform, widely umbilicate.

Type: (first species) *Horatia tellini* Poll.

Example: *Horatia micra* (P. and F.), fig. 118.

Subfamily POMATIOPSINÆ Stimpson, 1865.

Foot divided by a transverse sulcus at about its anterior third. Verge simple. Rachidian tooth with one basal denticle on each side, denticles of the lateral and marginal teeth fewer and proportionately larger than in the other subfamilies. Only one genus.

Genus POMATIOPSIS Tryon, 1862.

Shell dextral, spiral, thin, smooth, long, turreted, umbilicated; aperture somewhat expanded; lip simple or slightly reflected; operculum corneous, subspiral.

Fig. 119

Fig. 120

Fig. 121

Animal not as long as the shell, rostrum large, longer than the tentacles, which are short and subulate. Verge very large, simple, convoluted, outer margin rounded and smooth, inner margin sharp and wrinkled.
Type: *Cyclostoma lapidaria* Say, fig. 119. Animal, fig. 120. Radula, fig 121.

Family PLEUROCERIDÆ.

Animal oviparous, edge of mantle smooth; eyes on the external bases of the tentacles; no verge. Rachidian tooth large, broader than long, rounded below, multicuspid; laterals subrhomboidal, multicuspid; marginals narrow, multicuspid.

Shell dextral, spiral, thick and solid, globose or elongated; aperture entire or more or less canaliculated below, operculum corneous, subspiral.

Key to the genera of *Pleuroceridæ*.

1. Aperture canaliculate below ..... 2.
   Aperture angulated below, not canaliculate ..... 4.
   Aperture entire, rounded below ..... *Anculosa.*

2. Shell fusiform, canal long ..... *Io.*
   Shell conical, canal short ..... 3.

3. Spire elongated; no callus thickening on parietal wall.... *Pleurocera.*
   Spire short; parietal wall callously thickened above and below ..... *Lithasia.*
   Spire short; parietal wall callously thickened above..... *Eurycælon.*

4. Aperture entire above ..... *Goniobasis.*
   Aperture with a sutural slit ..... *Gyrotoma.*

Genus IO Lea, 1831.

Shell large, spiral, dextral, imperforate, fusiform, smooth, tuberculate or spinose; spire elevated, base of aperture prolonged in a long canal; columella round, smooth and concave; lip thin; operculum corneous, subspiral. Animal as in the family.

Type: *Fusus fluvialis* Say.

Example: *I. spinosa* Lea, fig. 122. Radula, fig. 123.

Fig. 122

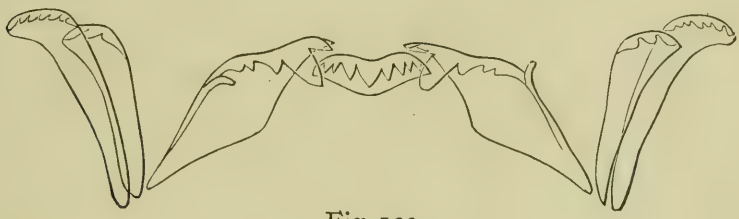


Fig. 123

Fig. 124

Fig. 125

Genus LITHASIA Haldeman, 1840.

Shell of medium size, spire dextral, imperforate, globose conic, smooth or tuberculate; thick and solid, spire elevated, obtusely conic; aperture large, rhomboidal; columella smooth, callously thickened above and below; base of the aperture shortly channelled below. Animal as in the family.

Type: *L. geniculata* Hald., fig. 124.

Operculum, *L. obovata* (Say), fig. 125.

Section ANGITREMA Haldeman, 1841.

Shell similar to *Lithasia* but with the basal canal more produced.

Type: *Melania armigera* Say, fig. 126.

Fig. 126

Genus EURYCÆLON Lea, 1864.

Fig. 127

Shell large, obovate, thick, solid; spire short; body-whorl large; columella callously thickened above, incurved below and subtruncate.

Type: *Anculosa anthonyi* Budd, fig. 127.

Genus PLEUROCERA Rafinesque, 1818.

Fig. 128

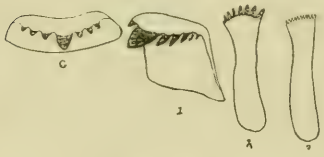


Fig. 129

Shell usually lengthened, conic or cerithiform, spiral, dextral, imperforate; smooth, tuberculate, spirally striate or carinate; aperture moderate, subrhomboidal, prolonged into a short canal below; columella smooth, twisted, not callously thickened; lip simple, sharp, sinuous, somewhat expanded.

Type: *P. acuta* Raf., fig. 128. Radula, fig. 129.

Section STREPHOBASIS Lea, 1861.

Fig. 130

Shell smooth, spire rather short, obtusely conical, body-whorl subcylindrical; aperture subquadrate; columella thickened below, twisted and drawn back, base subcanaliculate; lip acute, very sinuous.

Type: *Melania plena* Anth., fig. 130.

Genus GONIOBASIS Lea, 1862.

Fig. 131

Shell medium size, dextral, spiral, imperforate; smooth, longitudinally plicate, transversely striate or tuberculate; thick, solid, ovate-conic to elongate turreted; aperture subrhomboidal, subangular at the base but not canaliculate; columella smooth, not twisted; lip simple, acute.

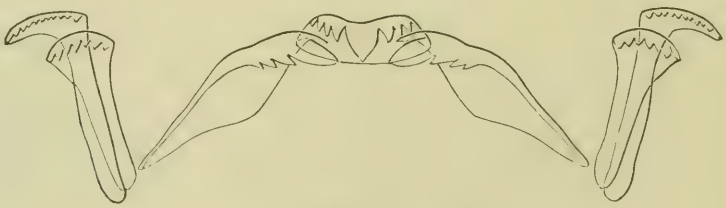


Fig. 132

Type: *G. osculata* Lea, fig. 131. Radula, *G. depygis* (Say), fig. 132.

Genus GYROTOMA Shuttleworth, 1845.

Shell of moderate size, spiral, dextral, imperforate, smooth or spirally striate, rather thick and solid, conical or globosely ovate; aperture oval or elliptical, with a sutural slit or fissure above, entire below; lip thin and sharp.

Fig. 133 Type: *G. ovoidea* Shutt., fig. 133. Radula, fig. 134.

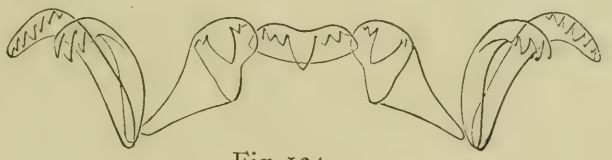


Fig. 134

Genus ANCULOSA Say, 1821.

Shell of moderate size, dextral, imperforate (except in one species), smooth, tuberculate, spirally striate, sulcate or carinate, thick, solid, subglobose with a very short spire or thinner and conical; aperture oval or subcircular, entire, rounded below; columella callously thickened; lip simple, acute.

Type: *Melania prærosa* Say, fig. 135. Radula, fig. 136.

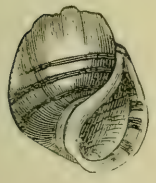


Fig. 135

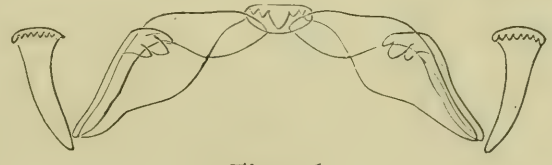


Fig. 136

Order ASPIDOBRANCHIA.

Suborder RHIPIDOGLOSSA.

The Rhipidoglossæ differ radically from the Tænioglossæ in the character of the lingual dentition. The radula has many rows of teeth, consisting of a central, 2-5 laterals and numerous marginals arranged like the sticks of a fan.

Family NERITIDÆ.

Head large, rostrum divided and lobed in front; tentacles long and slender; eyes carried on peduncles placed at the external base of the tentacles; foot large, truncate before and obtuse behind, sides simple; gill large, triangular, pointed, free at its extremity; branchial and excretory orifices

on the right side. Radula with a very small central tooth, 2 to 5 lateral teeth of varying size and shape and numerous spatulate marginals.

Shell imperforate, globose, spire short; internal divisions of the shell absorbed; aperture semi-ovate, entire, columellar region expanded and flattened, usually thickened; lip acute; operculum subspiral.

Key to the genera of *Neritidæ*.

1. Operculum calcareous, edge with projecting processes (apophyses) articulating with the columella.....*Neritina.*
2. Operculum corneous, without apophyses.....*Lepyrium.*

Genus NERITINA Lamarck, 1809.

Shell dextral, spiral, thick and solid, subglobose; spire short; surface smooth (in American species); aperture semi-circular, columella flattened, straight, smooth or finely denticulate; lip acute, inner surface smooth; operculum calcareous, semi-circular, paucispiral, nucleus excentric; with two apophyses, the upper shorter, sometimes dilated and crested; the lateral in the form of an arched rib.

Fig. 137

Fig. 138

Animal as in the family. Radula with the central tooth small, subquadrangular, cusp smooth; first lateral large, second and third small, fourth very large, prolonged below and with the cusp semicircular and denticulate, laterals numerous, spatulate.

Type: *N. perversa* Gmel.

Example: *N. reclivata* Say, fig. 137. Radula, fig. 138.

Fig. 139

Genus LEPYRIUM Dall, 1896.

Shell small, dextral, spiral, corneous, thin, semi-transparent; spire very small and depressed, body-whorl large; aperture large, semi-circular; columella concavely flattened, calloused, straight, smooth; lip thin, acute operculum thin, corneous, paucispiral without apophyses.

Radula with a wide rachidian tooth with a finely denticulated cusp; laterals two, the inner small and oblique, the other large with the cusp finely denticulate; laterals spatulate, numerous. Animal otherwise unknown.

Type: *Neritina showalteri* Lea, fig. 139.

Class LAMELLIBRANCHIA.

Order EULAMELLIBRANCHIA.

Suborder SUBMYTILACEA.

Key to the families of *Submytilacea*.

1.	Ligament external	2.
	Ligament internal	5.
2.	Hinge with cardinal, anterior and posterior lateral teeth	4.
	Hinge with cardinal teeth only	*Cyrenellidæ*.
	Hinge with lateral teeth only (no true cardinals) or edentate	3.
3.	Gills with distinct, interlamellar septa, parallel with the gill filaments	*Unionidæ*.
	Gills either without distinct, interlamellar septa or, when present, oblique to the gill-filaments	*Margaritanidæ*.
4.	Pallial line simple	*Sphæriidæ*.
	Pallial line sinuate	*Cyrenidæ*.
5.	Hinge with cardinal and lateral teeth	*Rangiidæ*.
	Hinge without distinct teeth	*Dreissensiidæ*.

Family MARGARITANIDÆ.

"Diaphragm incomplete, formed by the gills; posteriorly the outer lamina of the outer gills not connected with the mantle for a considerable distance; anterior end of the inner gills separated from the palpi by a gap; branchial and anal openings ill-defined, and the latter not closed above; no super-anal developed; gills without water-tubes and with scattered interlamellar connections, which in certain places form irregular rows or with continuous septa which run obliquely forwards; marsupium formed by all four gills; larva a small semicircular glochidium, without distinct hooks; shell elongated; sculpture of the beak concentric; hinge-teeth imperfect; epidermis blackish." (Ortmann.)

Genus MARGARITANA Schumacher, 1817.

Shell elongated, usually arcuate, rounded in front, almost lacking a posterior ridge; beaks rather low, sculpture consisting of a few coarse, parallel ridges which follow the growth lines; epidermis concentrically striate, brownish or blackish; hinge-teeth generally imperfect or not fully developed, two more or less perfect pseudocardinals in the left valve and one in the right, often reduced to mere tubercles; laterals short, usually imperfect or wholly wanting; cavity of the beaks rather shallow.

Key to the subgenera of *Margaritana*.

Gills with scattered interlamellar connections forming irregular rows running obliquely forwards.....*Margaritana s. s.*
Gills with continuous septa running obliquely forwards..*Cumberlandia.*

Subgenus MARGARITANA s. s.

Shell as in the genus.

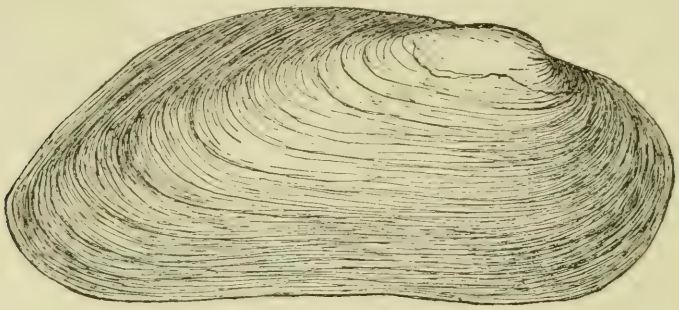


Fig. 140

Animal as in the family, but having the gills without water-tubes and with scattered interlamellar connections which in certain places form irregular rows, running obliquely forwards.

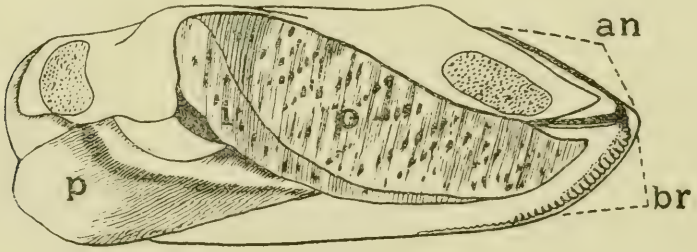


Fig. 141*

Type: *Mya margaritifera* L., fig. 140. Animal, fig. 141.

* The following lettering applies to all the figures of the animals of the Margaritanidæ and Unionidæ except as otherwise stated:

an.—anal opening.
br.—branchial opening.
f.—flaps of margin of mantle.
i.—inner gill.
o.—outer gill.
p.—foot.
pp.—papillæ on margin of mantle.
sa.—supra-anal opening.
mp.—marsupium.

Subgenus CUMBERLANDIA Ortmann, 1912.

Shell as in the genus.

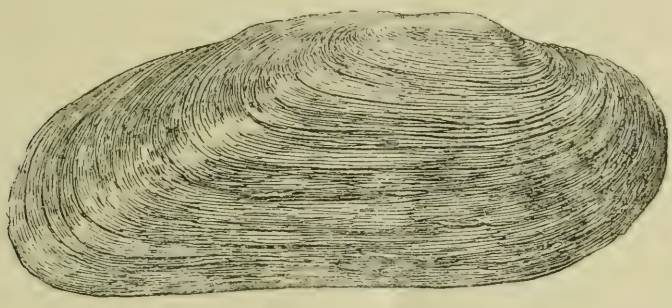


Fig. 142

Animal as in the family, but having the gills with incomplete water-tubes and with continuous septa, which run obliquely forwards.

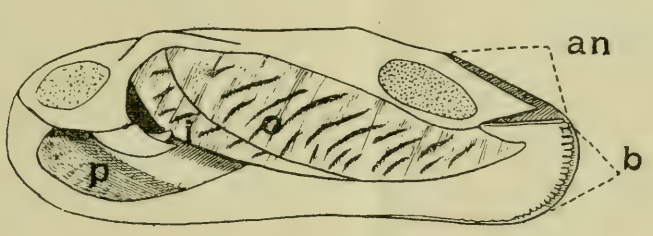


Fig. 143

Type: *Unio monodonta* Say, fig. 142. Animal, fig. 143.

Family UNIONIDÆ.

"Diaphragm complete, formed by the gills; posteriorly the outer lamina of the outer gill connected with the mantle to its posterior end; anterior end of the inner gills separated from the palpi by a gap; branchial and anal openings sharply separated from one another by the diaphragm; anal openings very rarely not closed above and without supra-anal, generally closed and with a supra-anal opening (which very rarely may be obliterated); gills with water-tubes and distinct, interlamellar septa, running parallel to the filaments. Marsupium in all four gills or only in the outer gills; larva a glochidium. Shell of very variable shape; sculpture of the beak more or less reduced, of various types, but originally of the concentric or zig-zag pattern; hinge teeth perfect or imperfect; epidermis plain or with color-markings." (Ortmann.)

Key to the subfamilies of *Unionidæ*.

1. Water-tubes simple in the gravid female 2
   Water-tubes in the gravid female divided into three tubes, of which only the centre one is used as an ovisac ..... *Anodontinæ*.

2. Male and female shells usually alike; edge of the gravid marsupium always sharp and not distending ..... *Unioninæ*.
   Male and female shells usually different; edge of the gravid marsupium distending and bulging out beyond the original edge of the gill ..... *Lampsilinæ*.

Subfamily UNIONINÆ (Swainson, 1840) Ortmann, 1910.

"Inner lamina of the inner gills generally free from the abdominal sac (sometimes, in extralimital forms, connected); supra-anal opening sometimes not separated from the anal, normally present, the closed part rather short; branchial opening well-defined; no papillae nor flaps on the edge of mantle in front; marsupium formed by all four gills or by the outer gills only; edge of marsupium always sharp and not distending; water-tubes not divided in the gravid female; glochidium semielliptic or semicircular, without spines; shell generally heavy and solid, rounded to elongated, mostly with dull-colored epidermis; sculpture of the beak generally rather indistinct, concentric or pustulous or with indications of double loops or zig-zag bars; hinge always complete, with rather strong teeth; generally no difference of sex shown in the shell." (Ortmann.)

Key to the genera of *Unioninæ*.

1. All four gills serving as marsupia ..... 2.
   Outer gills only serving as marsupia ..... 6.

2. Male and female shells alike ..... 3.
   Male and female shells different ..... *Tritogonia*.

3. Hinge with perfect pseudocardinals and laterals ..... 4.
   Hinge teeth rudimentary or wanting ..... *Gonidea*.

4. Surface plicate ..... 5.
   Surface pustulose ..... *Quadrula*.
   Surface smooth ..... *Fusconaia*.

5. Beaks sculptured with coarse, concentric or somewhat double-looped ridges, which do not extend over the surface. *Amblema*.
   Beaks sculptured with strong, zig-zag ridges extending over the upper surface ..... *Megalonaias*.

6. Surface tuberculous 7
   Surface smooth or spiny ..... 8.

7. Nacre deep purple ..... *Rotundaria.*
   Nacre white or tinged with pink ..... *Plethobasus.*

8. Hinge with perfect pseudocardinals and laterals ..... 9.
   Hinge teeth imperfect, vestigial ..... *Lastena.*

9. Shell short, rounded, quadrate or oblique ..... 10.
   Shell (usually) elongate and straight ..... 11.

10. Beak sculpture distinct, subconcentric, rounded upon the posterior slope ..... *Lexingtonia.*
    Beak sculpture coarser, inclined to be more or less double-looped ..... *Pleurobema.*

11. Beak sculpture running parallel with the growth-lines and angled on the posterior slope ..... *Elliptio.*
    Beak sculpture concentric, rounded behind ..... *Uniomerus.*

Genus QUADRULA (Rafinesque, 1820) Agassiz.

Shell triangular, quadrate or rhomboid; solid, inflated with rather coarse prominent beaks, which are generally sculptured with a few coarse, irregular, subparallel ridges that are inflated where they cross the posterior ridge; posterior ridge ordinarily well developed; disk sculptured or smooth; epidermis usually dull-colored, dark and rayless or feebly rayed; hinge plate heavy, wide, flattened; pseudocardinals solid, direct, ragged; laterals double in the left and single in the right valve; cavity of the beaks deep and compressed. Marsupium occupying all four of the gills throughout, the whole smooth and pad-like.

Key to the sections of *Quadrula.*

Posterior slope with a radial furrow above the posterior ridge ..... *Quadrula s. s.*
No radial furrow above posterior ridge ..... *Theliderma.*

Section QUADRULA s. s.

Shell quadrate or rhomboid; surface pustulous, with a high, rounded or sharp posterior ridge, above which on the posterior slope is a decided

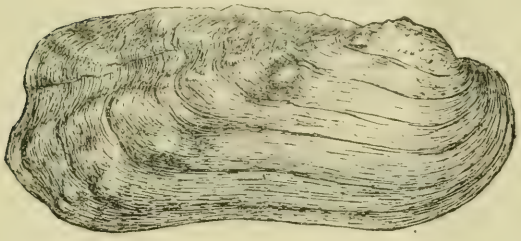


Fig. 144

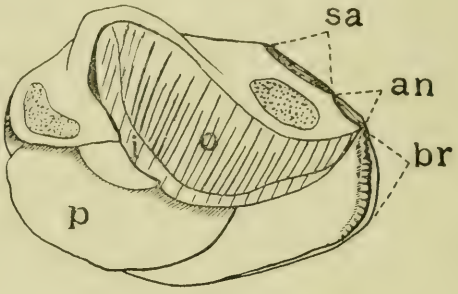


Fig. 145

radial furrow; umbonal region high; epidermis shining, usually painted with a beautiful pattern of triangular spots or chevron-shaped lines.

Type: *Unio cylindricus* Say, fig. 144. Animal, *Q. metanevra* Raf., fig. 145.

Section THELIDERMA (Swainson, 1840) Simpson.

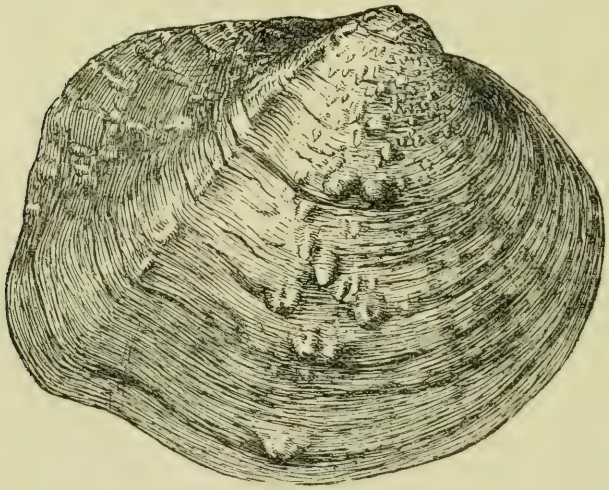


Fig. 146

Shell rounded, quadrate to rhomboid, solid, pustulous; beaks rather prominent, sculpture consisting of a few, rather coarse, subparallel ridges; anterior end rounded, base often arcuate, posterior end truncate, high and angled behind the ligament, epidermis rarely rayed, never as in *Quadrula s. s.*

Type: *Unio lachrymosus* Lea, fig. 146.

Genus TRITOGONIA Agassiz, 1852.

Shell solid, elongate, rhomboid, having a strong, irregular posterior ridge, obliquely truncated behind in the male, in the female this region is somewhat compressed and expanded into a broad wing; base curved; whole surface, except the rounded wing of the females, covered with pustules;

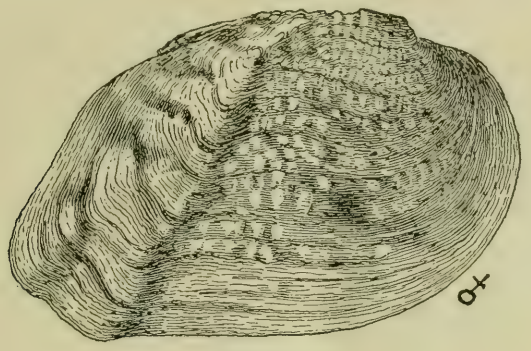


Fig. 147

beaks rather low, incurved and turned forward over the well developed lunule; beak sculpture strong, consisting of irregular, subparallel ridges which are curved upwards behind and fine radiating ridges in front of and behind them; epidermis dark olive; hinge plate rather narrow; pseudo-

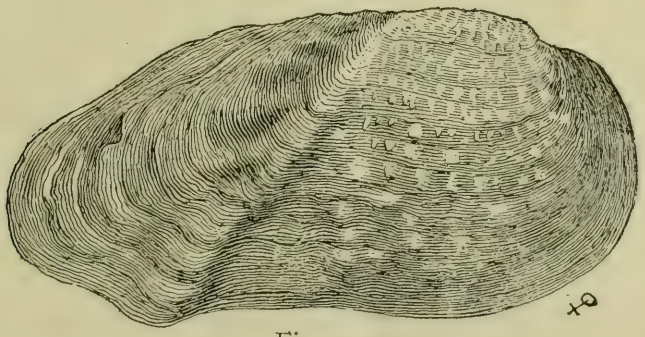


Fig. 147

cardinals strong, ragged; laterals long and straight, near to the pseudo-cardinals; cavity of beaks rather deep and compressed; female shell more compressed than that of the male. Marsupium occupying all four gills.

Type: *Unio tuberculatus* Bar., fig. 147.

Genus MEGALONAIAS Utterback, 1915.

Shell large, heavy, obovate or rhomboid, alate post-dorsally, disk obliquely folded; beaks sculptured with coarse, double-looped corrugations, which extend over the upper surface of the disk as nodulous plications; epidermis

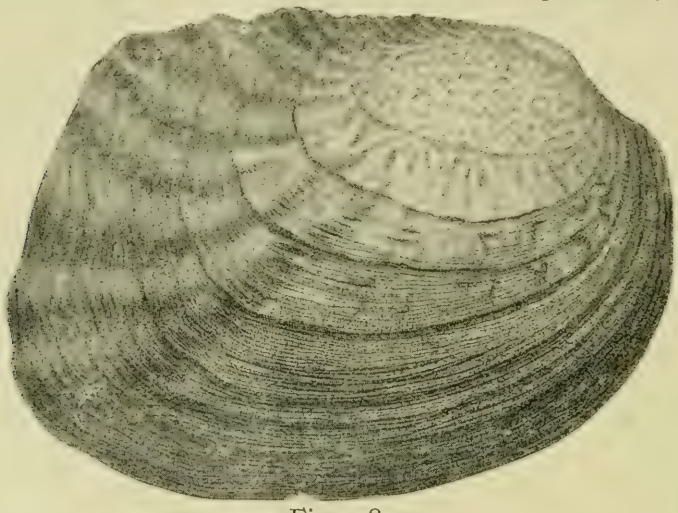


Fig. 148

dark-brown or blackish; beak cavities narrow and deep; anterior muscle scars deep and filled with a nacreous deposit, posterior scars large and indistinct.

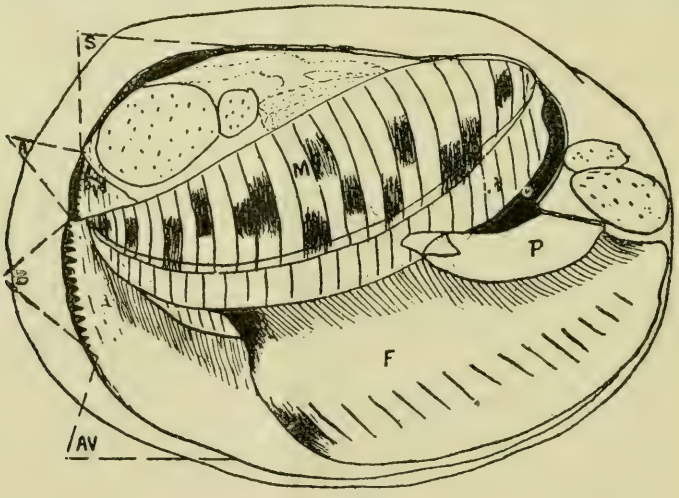


Fig. 149*

Type: *Unio heros* Say, fig. 148. Animal, fig. 149.

* The following lettering applies to figs. 149, 165 and 201:

A.—Anal opening.	F.—Foot.	P.—Palp.
Av.—Antero-ventral margin.	I.—Inner gill.	S.—Supra-anal opening.
B.—Branchial opening.	M.—Marsupium.	

Genus AMBLEMA Rafinesque, 1819.

Shell more or less alate; beaks prominent, sculptured with coarse, concentric or somewhat double-looped ridges which do not extend over the surface of the shell; surface of the valves usually sculptured with oblique folds; posterior slope generally having small radial plications, which curve

Fig. 150

upwards behind; epidermis brownish or blackish; anterior muscle scars large, distinct, very shallow, the anterior edge smooth, the rest apparently filled with roughened shelly matter; posterior scars large, shallow, indistinct; escutcheon large and dark.

Marsupium occupying all four gills.

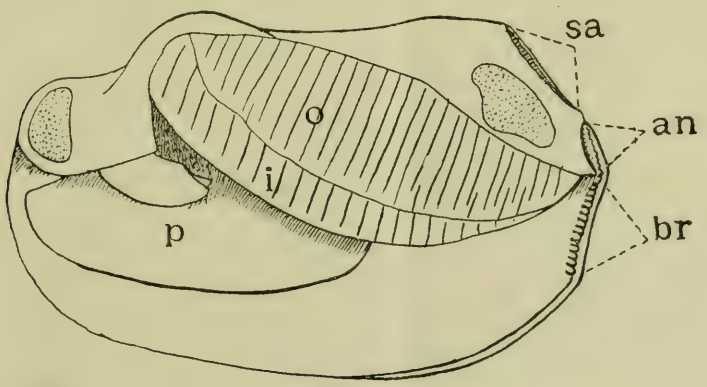


Fig. 151

Type: *A. costata* Raf.

Example: *A. undulata* (Bar.), fig. 150. Animal, *A. trapezoides* (Lea), fig. 151.

Genus FUSCONAIA Simpson, 1900.

Shell round, rhomboid, triangular or short elliptical, with a moderate posterior ridge; beaks high and full, curved inward and forward, sculptured with a few coarse, parallel ridges, which curve upward behind; epi-

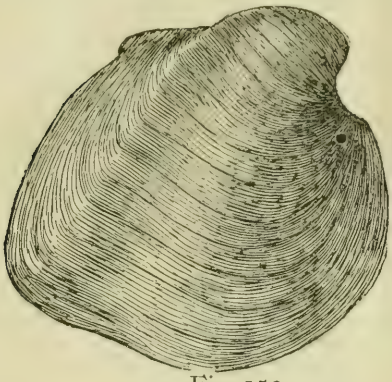


Fig. 152

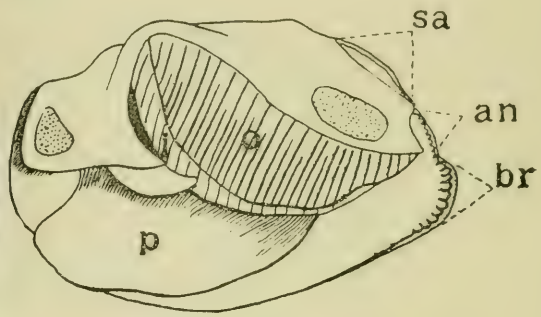


Fig. 153

dermis dark; surface not sculptured; hinge plate of moderate width; pseudocardinals strong; nacre white, salmon or purple.

All four gills marsupial.

Type: *Unio trigonus* Lea, fig. 152. Animal, (*F. rubiginosa* (Lea)), fig. 153.

Genus ROTUNDARIA (Rafinesque, 1820) Simpson.

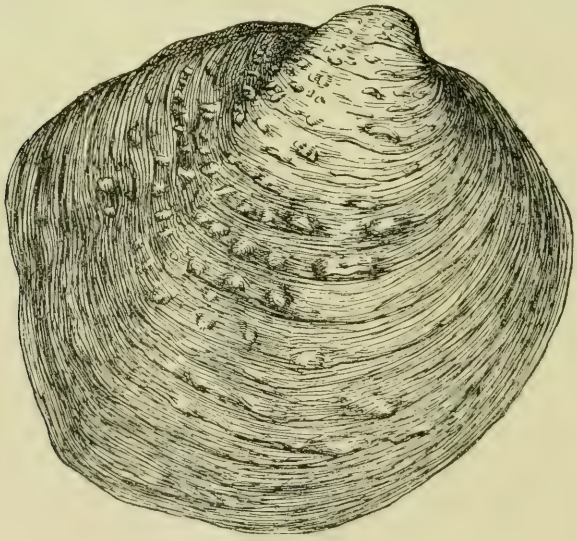


Fig. 154

Shell rounded; slightly truncated above in front; posterior ridge low beaks prominent, curved inward and forward over a strongly marked lu

ule; beak sculpture consisting of numerous, fine, irregular, broken, somewhat concentric corrugations; posterior three-fifths of the shell tuberculate; epidermis brown; nacre purple.

Only the outer gills serving as marsupium.

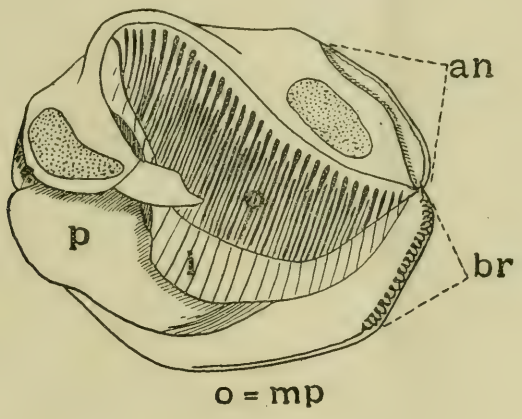


Fig. 155

Type: *Obliquaria* (*Rotundaria*) *tuberculata* Raf., fig. 154. Animal, fig. 155.

Genus PLETHOBASUS Simpson, 1900.

Shell large, irregularly oval, inflated, solid, somewhat suddenly swollen at the posterior base; posterior ridge low and rounded; beaks rather high, near the anterior end, having a few strong ridges, which are curved up-

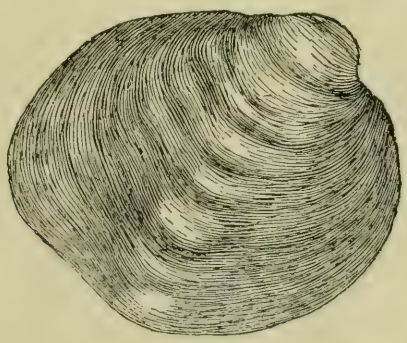


Fig. 156

wards behind; a row of low, irregular tubercles extends from near the beaks to post-basal part of the valves; epidermis tawny yellow to dark brown; hinge plate solid, not flattened; pseudo-cardinals triangular, rough;

cavity of the beaks not deep; front part of the shell very heavy, thinner behind.

Outer gills only serving as marsupium.

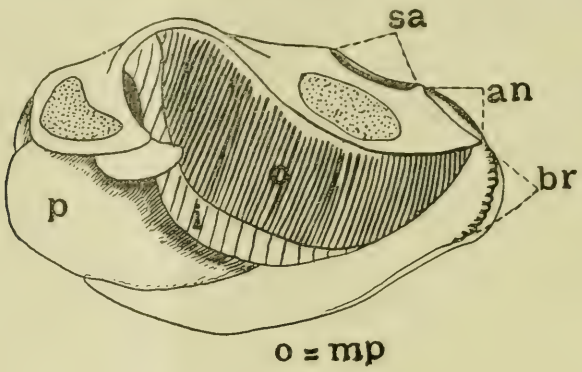


Fig. 157

Type: *Unio æsopus* Green, fig. 156. Animal, fig. 157.

Genus PLEUROBEMA (Rafinesque, 1820) Agassiz.

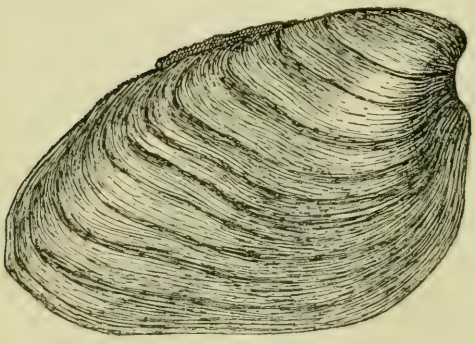


Fig. 158

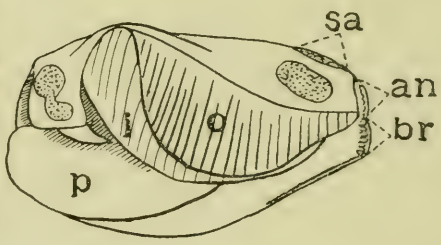


Fig. 159

Shell solid, triangular to rhomboid, usually with a prominent umbonal region; beaks at or near the anterior end of the shell, incurved and pointed forward over a small, but well developed lunule; beak sculpture coarse, consisting of a few, often broken, ridges, which curve upward posteriorly; posterior ridge present, but low and rounded; epidermis showing the rest periods plainly, tawny to olive, often ornamented with rays which show a tendency to break into square spots; hinge rather strong, plate generally narrow; pseudocardinals double in both valves. Cavity of the beaks shallow.

Outer gills only serving as marsupium.

Type: *Unio clava* Lam., fig. 158. Animal, fig. 159.

Genus LEXINGTONIA Ortmann, 1914.

"Shell subquadrate or subtrapezoidal, with slightly elevated beaks and well developed hinge teeth. Beaks not much anterior. Outer surface without sculpture. Epidermis lighter or darker brownish, with rather indistinct rays, which are narrower or wider and do not break up into blotches. Beak sculpture distinct, consisting of rather numerous (six to eight), rather crowded, subconcentric ridges, which form an indistinct, rounded angle upon the posterior ridge and are in front of this somewhat wavy and corrugated, but without showing any distinct zigzag pattern. Towards the disk, they disappear. Nacre whitish or pinkish."

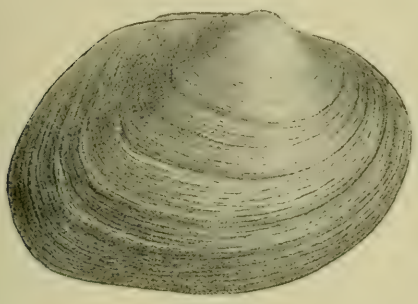


Fig. 160

Animal having only the outer gills marsupial and subcylindrical, red placentæ.

Type: *Unio subplanus* Con., fig. 160.

Genus ELLIPTIO Rafinesque, 1819.

Shell inequilateral, ovate to elongated, rounded in front and pointed or biangulate behind, with a more or less developed posterior ridge, often becoming slightly arcuate when old; beaks only moderately full, generally sculptured with coarse ridges, which run parallel with the growth lines or are somewhat doubly looped, sometimes broken and showing fine radiating lines behind; surface smooth, slightly concentrically ridged or pustulous: epidermis generally rather dull colored, rayless or fully rayed; hinge-plate narrow, two pseudocardinals and two laterals in the left valve and one pseudocardinal and one lateral in the right, with rarely a vestige of a second lateral; cavity of the beaks not deep or compressed. Marsupium occupying the whole length of the outer gills only, forming a thick, smooth pad when filled with young.

Key to the sections of *Elliptio*.

Shell spinose ..... *Canthyria.*
Shell smooth or feebly corrugated..... *Elliptio s. s.*

Section ELLIPTIO s. s. .

Shell elongated, rhomboid or oval, usually more or less biangulate behind; beak sculpture consisting of a few rather strong ridges, which are nearly parallel to the growth lines or slightly doubly looped; the surface smooth or feebly corrugated.

Type: *Unio crassidens* Lam., fig. 161. Animal, fig. 162.

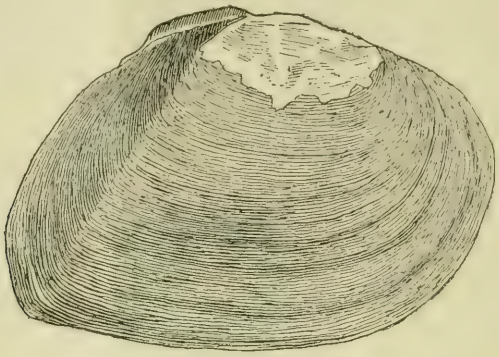


Fig. 161

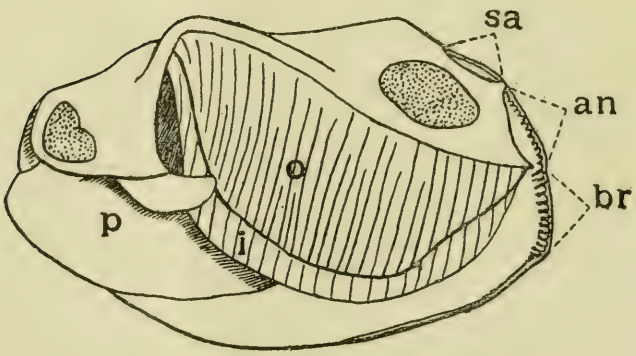


Fig. 162

Section CANTHYRIA Swainson, 1840.

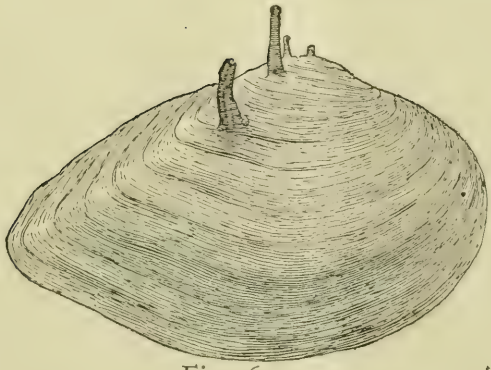


Fig. 163

Shell inflated, suboval, spinose, with a high, rather sharp posterior ridge, above which it is somewhat truncated; beaks rather compressed; epidermis smooth and shining, variegated with angular blotches; hinge sharply curved at the centre; pseudocardinals rather compressed; laterals short, remote; beak cavities rather deep.

Type: *Unio spinosus* Lea, fig. 163.

Genus UNIOMERUS Conrad, 1853.

Shell trapezoidal, with a rounded posterior ridge and pointed or feebly biangulate behind; beaks not prominent, sculptured with curved, rather

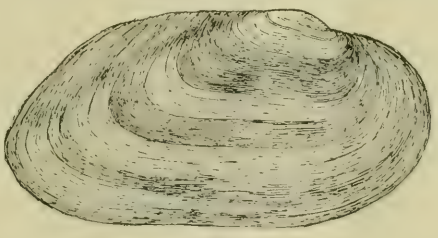


Fig. 164

strong, concentric ridges; epidermis generally rayless; pseudocardinals usually compressed, laterals delicate, slightly curved.

Outer gills only marsupial.

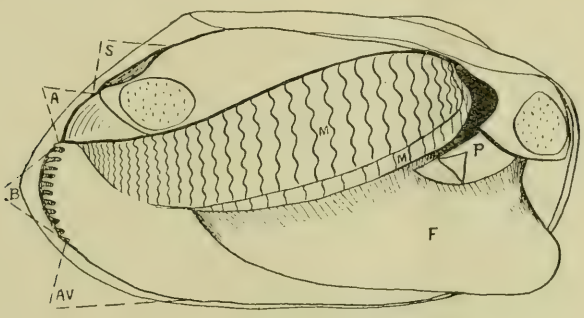


Fig. 165

Type: *Unio tetralasmus* Say, fig. 164. Animal, fig. 165.

Genus LASTENA Rafinesque, 1820.

Shell elongated, subsolid, inequilateral, generally wider in front, rounded and truncate at the anterior base, pointed at the post-basal region, and hav-

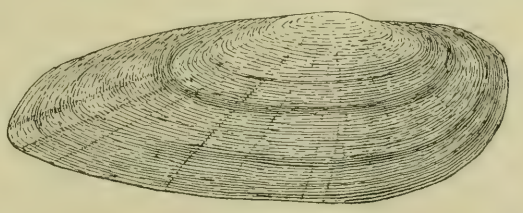


Fig. 166

ing a low posterior ridge, with one or more secondary ridges above it; beaks low, sculptured with a few coarse, irregular, longitudinal folds; epi-

dermis shining, often rayed; a single imperfect tooth in each valve and sometimes vestiges of laterals; nacre purplish shading to blue at the edge; pallial line radially ridged.

Animal having the foot very large, as long as the shell when extended, of a subcylindrical, compressed shape, with a distal swelling. The middle portion of the outer gills only marsupial. Glochidia semicircular, slightly oblique, inequivalve, without points or hooks.

Type: *Anodonta (Lastena) lata* Raf., fig. 166.

Genus GONIDEA Conrad, 1857.

Shell elongated, subtriangular, much narrowed in front, wide behind, inflated, subsolid, usually with a high, sharp posterior ridge; beaks rather sharp but not high, the sculpture consisting of a few, strong, concentric bars; epidermis rayless; hinge with a rudimentary pseudocardinal and lateral in each valve, though these are sometimes wanting; pallial line with a trace of a sinus behind; nacre lurid to purplish.

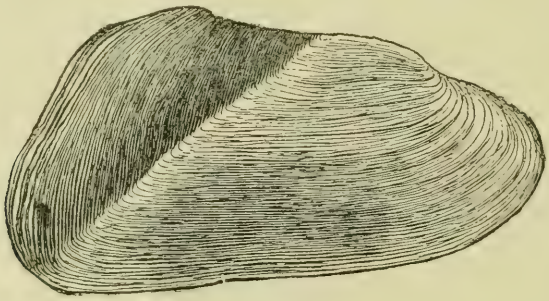


Fig. 167

Female having all four gills marsupial; with well developed septa, running parallel to the gill filaments and forming water tubes; septa not all continuous, but are often interupted, chiefly so toward the proximal (basal) part of the gill and, towards the edge, frequently shorter septa are intercalated. Glochidia subovate or nearly subcircular, without hooks.

Type: *Anodonta angulata* Lea, fig. 167.

Subfamily ANODONTINÆ Ortmann, 1912.

"Inner lamina of inner gill free from the abdominal sac, or more or less connected with it, rarely entirely connected; supra-anal opening well separated from the anal, sometimes the connection of the mantle separating it from the anal is very long and the supra-anal is quite short; branchial opening well defined, no papillæ or flaps in front of it on the edge of the mantle; marsupium formed by the outer gills in their length, distending, when

charged, and the thickened tissue at the edge capable of stretching out in a direction transverse to the gill, but not beyond the edge (or only slightly so); water-tubes in the gravid female divided longitudinally into three tubes, with only the one in the middle used as an ovisac, and closed at the base of the gill; glochidium semicircular or triangular, with a spine (hook), in the middle of the ventral margin of each valve; shell generally very heavy, often thin, never round, but more or less elongated; color of epidermis generally bright and with color markings; sculpture of the beak double-looped or concentric, in the latter case often extremely heavy; hinge rarely complete and, if so, of peculiar structure; generally there is a distinct tendency toward the reduction of the hinge-teeth, and often they are completely absent; sexual differences in the shell very rarely present." (Ortmann.)

Key to the genera of *Anodontinæ*.

1. Beak sculpture concentric ..... 2.
   Beak sculpture double-looped ..... 4.

2. Beak sculpture fine ..... *Anodontoides.*
   Beak sculpture coarse ..... 3.

3. Pseudocardinals well developed ..... *Alasmidonta.*
   Pseudocardinals rudimentary ..... *Strophitus.*

4. Hinge wholly edentulous ..... *Anodonta.*
   Hinge teeth more or less developed ..... 5.

5. Beak sculpture tubercular; surface tubercular or folded ..... 6.
   Beak sculpture not tubercular; surface smooth except on posterior slope ..... 7.

6. Beak sculpture strong and continuous with tubercular surface sculpture ..... *Arcidens.*
   Beak sculpture poorly developed and not continuous with surface sculpture ..... *Arkansia.*

7. Beak sculpture double-looped; pseudo-cardinals fully developed ..... *Lasmigona.*
   Beak sculpture open behind; a single pseudo-cardinal in each valve ..... *Simpsoniconcha.*

Genus STROPHITUS Rafinesque, 1820.

Shell elliptical to rhomboid, inflated, subsolid, pointed or biangulate behind, with a low posterior ridge, which is sometimes double; beaks full, sculpture consisting of a few, strong, concentric ridges, which curve sharply

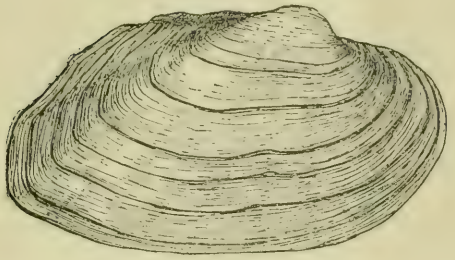


Fig. 168

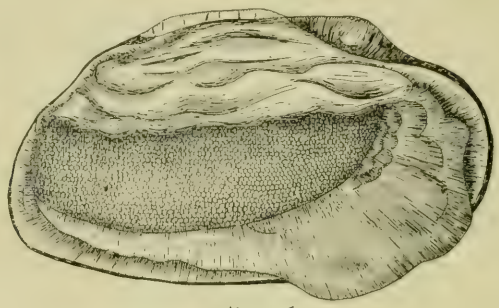


Fig. 169

upwards behind; epidermis rayed or rayless, shining; hinge line incurved in front of the beaks; teeth rudimentary, a vestigial, compressed tooth in each valve, and sometimes a secondary tooth; laterals rarely present. Marsupium occupying the whole of the outer gills, consisting of short, horizontal ovisacs, which run directly across the gills.

Type: *Anodonta undulata* Say.
Example: *S. edentulus* (Say), fig. 168. Animal, fig. 169.

Genus ANODONTA Lamarck, 1799.

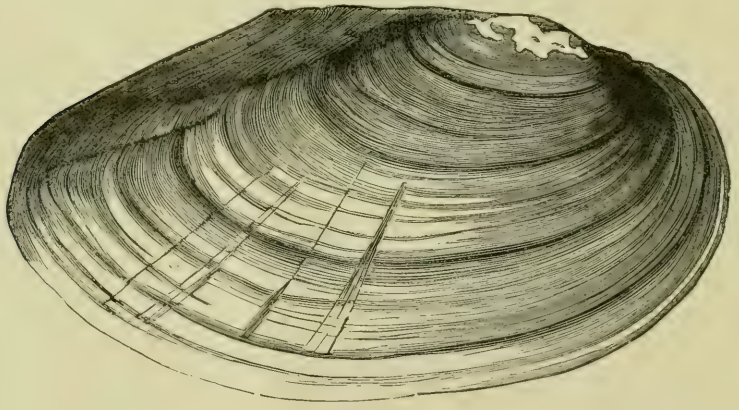


Fig. 170

Shell elliptical, thin, inflated, often slightly winged posteriorly; beak sculpture consisting of rather numerous, more or less parallel ridges, usually somewhat doubly looped and becoming slightly nodulous on the loops; surface generally smooth, shining; hinge edentulous, reduced to a mere line, regularly curved; nacre dull.

Marsupium occupying the whole outer gills, when filled forming a smooth, very thick, liver-colored pad.

Type: *Mytilus cygneus* L.

Example: *A. cataracta* Say, fig. 170. Animal, fig. 171.

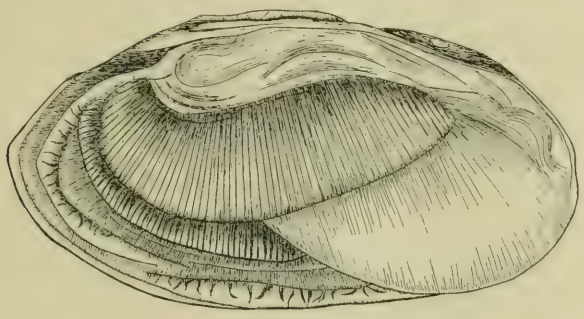


Fig. 171

Genus ANODONTOIDES Simpson, 1898.

Shell elliptical, inflated, thin, with a faint posterior ridge, sometimes constricted at the centre of the base; beaks rather full, with a few, not very coarse, subparallel, concentric ridges, which are curved up rather suddenly, behind and back of these are fine radiating ridges; epidermis smooth and

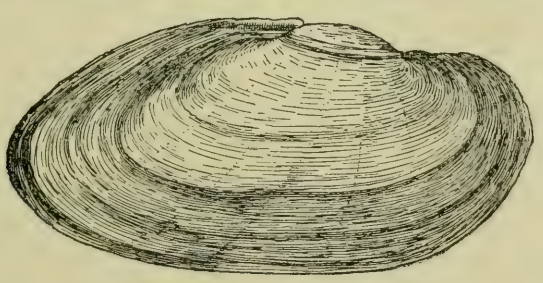


Fig. 172

shining, often rayed; hinge line slightly incurved in front of the beaks, edentulous or bearing the merest rudiments of teeth; nacre bluish-white. Marsupium occupying the outer gills only.

Type: *Anodonta ferussaciana* Lea, fig. 172.

Genus ARCIDENS Simpson, 1900.

Shell subsolid, inflated, subrhomboidal, with full high beaks; beak sculpture very strong, consisting of irregular corrugations, which fall into two loops, at the base of which the ridges are swollen into knobs that continue out in two radiating rows on to the disk of the shell; in front of and behind the beaks are many fine, radial wrinkles, the posterior ones being zig-

zagged; surface of the shell covered with oblique folds and wrinkles; epidermis dark olive, shining; left valve with two elongated, compressed pseudocardinals, the posterior under the beak and curved upwards, cutting off

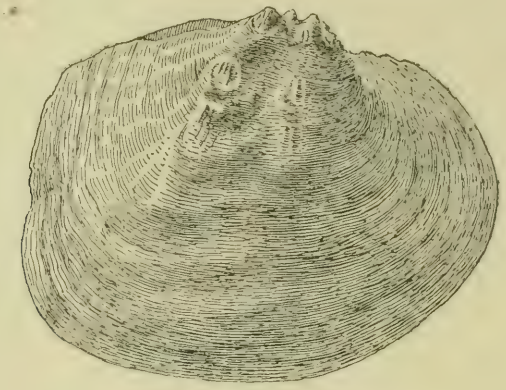


Fig. 173

the hinge plate in the right valve, which has a single, compressed pseudocardinal in front; laterals numerous, short, blurred; nacre white. Marsupium occupying the outer gills.

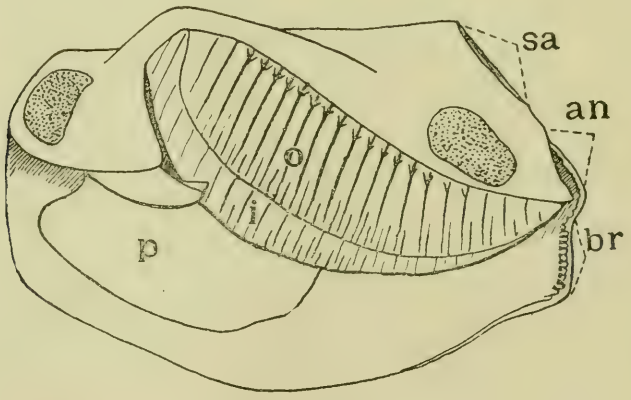


Fig. 174

Type: *Alasmodonta confragosa* Say, fig. 173. Animal, fig. 174.

Genus ARKANSIA Ortmann and Walker, 1912.

Shell moderately thick, subrotund to subovate or subrhomboidal, inflated, with full beaks. Disk sculptured with irregular, oblique folds, which are sometimes indistinct. Beak sculpture poorly developed, consisting of two to three double-looped bars, the loops slightly swollen or tubercular, dis-

appearing toward the disk and not continuous with the sculpture of the latter. Hinge well developed, with strong pseudocardinals, a very strong

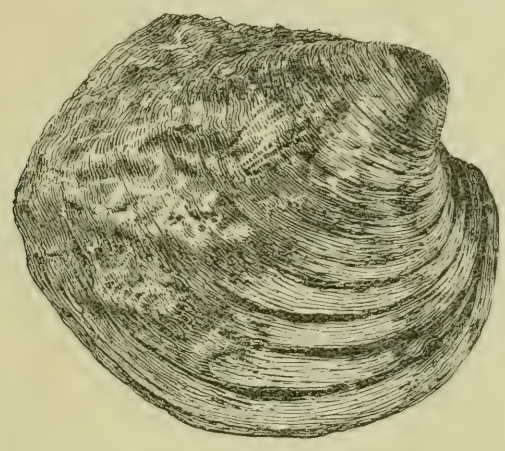


Fig. 175

interdental projection in the left valve and well developed, strong, but rather short laterals.

Outer gills only marsupial.

Type: *Arkansia wheeleri* O. and W., fig. 175.

Genus LASMIGONA Rafinesque, 1831.

Shell elliptic-rhomboid, compressed; beaks low, their sculpture consisting of strong bars; one pseudocardinal in the right valve and two in the left, the hinder somewhat ∧-shaped, cutting off the hinge-plate in the right valve; laterals generally imperfect. Marsupium thick, padlike, filling the outer gills.

Key to the subgenera of *Lasmigona*.

1. Shell corrugated on posterior slope ..... *Lasmigona s. s.*
   Shell smooth ..... 2.
2. Hinge teeth delicate ..... 3.
   Hinge teeth very heavy ..... *Pterosyna.*
3. Lateral teeth compressed, moderately developed ..... *Platynaias.*
   Lateral teeth nearly or quite wanting ..... *Alasmidonta.*

Subgenus PLATYNAIAS Walker, 1917.

Shell smooth, subsolid, shining, rayed; beak sculpture sharply double-looped; teeth delicate; laterals compressed, moderately developed.

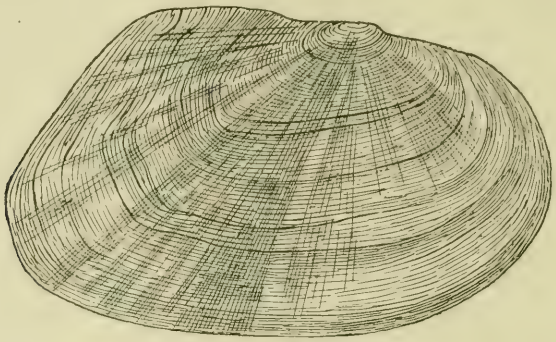


Fig. 176

Type: *Symphynota compressa* Lea, fig. 176.

Subgenus LASMIGONA s. s.

Shell subrhomboid, compressed, corrugated behind; beaks low, their sculpture consisting of several coarse ridges, which generally fall into two slight loops, and often with radiating ridges in front and behind; epidermis

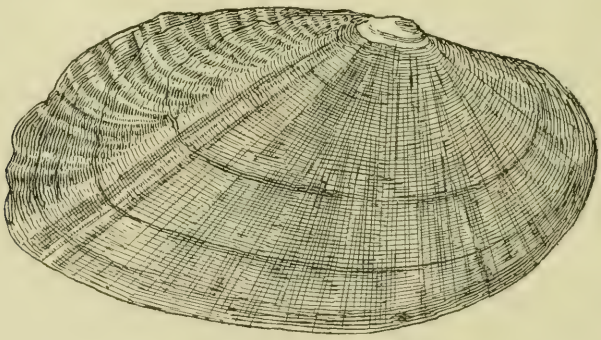


Fig. 177

shining; laterals partly developed, consisting of blurred ridges, which slope diagonally downward and backward on the hinge-plate; cavities of the beaks shallow.

Type: *Alasmidonta costata* Raf., fig. 177.

Subgenus ALASMINOTA Ortmann, 1914.

Shell elongated elliptical, rather small. Surface without sculpture. Pseudocardinals delicate; laterals nearly or quite wanting. Beak sculpture not heavy, consisting of four to six rather fine, sharp bars, the first one or

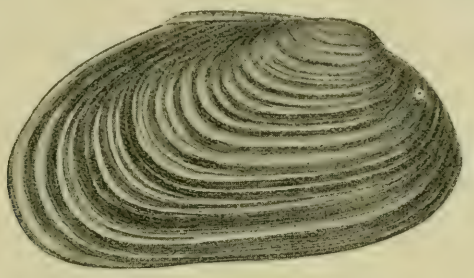


Fig. 178

two subconcentric, the following ones sharply double-looped, the posterior loop smaller, separated from the anterior by a deep, sharp, re-entering angle.

Type: *Margaritana holstonia* Lea, fig. 178.

Subgenus PTEROSYNA Rafinesque, 1831.

Shell large, ovate-rhomboid, inflated in the post-basal region; beaks much compressed; their sculpture sharply and strongly doubly looped; epidermis dark, scarcely rayed; teeth very heavy.

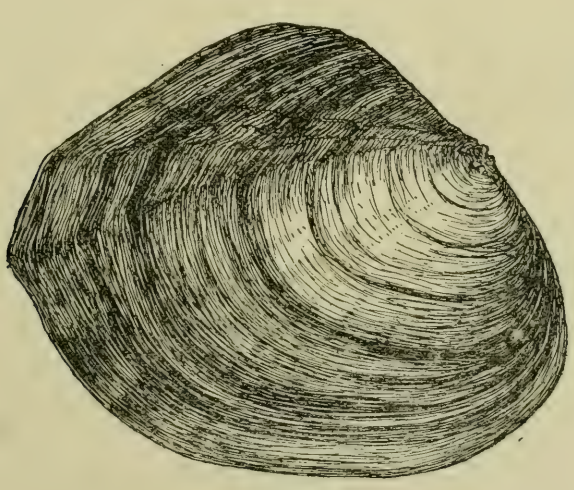


Fig. 179

Type: *Alasmodonta complanata* Bar., fig. 179.

Genus ALASMIDONTA Say, 1818.

Shell generally rhomboid, inflated, with a well developed posterior ridge, which ends in a point when it is single or a biangulation when double; beaks full and high, with coarse, concentric or slightly doubly looped bars; epidermis rayed, shining; hinge with two pseudocardinals in the left valve and one in the right; laterals usually wanting or imperfect, present in *Prolasmidonta,* cavity of the beaks deep; nacre bluish. Marsupium occupying the entire outer gills.

Key to the subgenera of *Alasmidonta.*

1. Lateral teeth present ..... *Prolasmidonta.*
   Lateral teeth absent or obsolete ..... 2.
2. Shell solid, pseudocardinals solid, stumpy ..... 3.
   Shell thinner, pseudocardinals compressed or imperfect ..... 4.
3. Shell ovate-rhomboid, inflated ..... *Alasmidonta s. s.*
   Shell smaller, compressed, very solid ..... *Pegias.*
4. Posterior slope slightly corrugated ..... *Rugifera.*
   Posterior slope smooth ..... 5.
5. Shell rhomboid, posterior ridge low, rounded ..... *Pressodonta.*
   Shell subtriangular, posterior ridge high, sharp ..... *Bullella.*

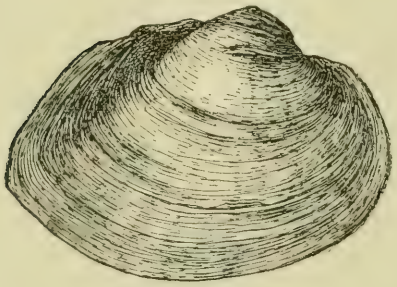


Fig. 180

Subgenus ALASMIDONTA s. s.

Shell ovate-rhomboid, solid, inflated, shining, with very strong, generally concentric, beak sculpture; pseudocardinals solid, stumpy, somewhat radiately ridged; laterals short, very imperfect or wanting; beak cavities deep, compressed.

Type: *Monodonta undulata* Say, fig. 180.

Subgenus PRESSODONTA Simpson, 1900.

Shell small, decidedly rhomboid, surface generally painted with unbroken rays; beak sculpture slightly corrugated; teeth compressed.

Type: *Unio calceolus* Lea, fig. 181.

Fig. 181

Subgenus PROLASMIDONTA Ortmann, 1914.

Lateral hinge teeth present, but their number reversed, two in the right, one in the left valve. Beak sculpture moderately heavy, bars with an angle upon the posterior ridge and a slight sinus in front of it. Inner lamina of inner gills free. Female shell recognizable by a slight swelling in the region of the posterior ridge.

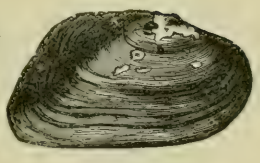


Fig. 182

Type: *Unio heterodon* Lea, fig. 182.

Subgenus PEGIAS Simpson, 1900.

Fig. 183

Shell small, thickened in front, with a sharp posterior ridge, in front of which is a wide, radial impression, ending in a basal sinus; above this ridge is another, making the shell decidedly biangulate and truncate behind; beak sculpture consisting of sub-conic corrugations, generally swollen on the posterior ridge; epidermis decorticated, but showing a few, dark radial rays on the base of the shell; pseudocardinals rather solid; laterals wanting.

Type: *Margaritana fabula* Lea, fig. 183.

Subgenus RUGIFERA Simpson, 1900.

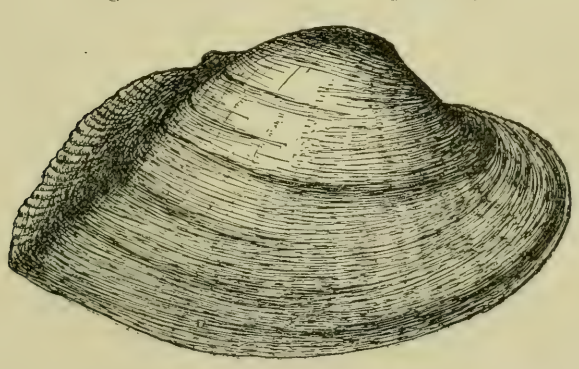


Fig. 184

Shell elongated, rhomboid, inflated, surface brilliantly painted with radiations which often break into dappled or splashed pattern of color; posterior slope slightly corrugated; teeth very imperfect; laterals wanting.

Type: *Alasmodonta marginata* Say, fig. 184.

Subgenus BULLELLA Simpson, 1900.

Shell thin, greatly inflated, somewhat triangular, with a high, sharp posterior ridge; beaks very full, having exceedingly strong, concentric sculpture, extending well on to the disk; pseudocardinals reflexed, compressed.

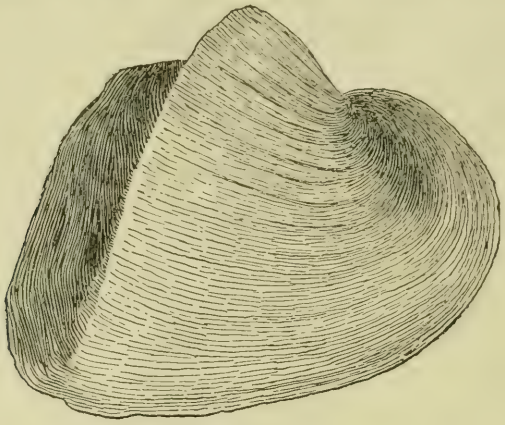


Fig. 185

Type: *Margaritana arcula* Lea, fig. 185.

Genus SIMPSONICONCHA Frierson, 1914.

Fig. 186

Shell small, elongate elliptical, rounded in front and behind, often slightly incurved at the central base; beak rather sharp, but not full; sculpture consisting of fine parallel ridges which are looped up in the middle and open behind; epidermis brownish, rayless; teeth imperfect, a single, irregular, compressed tooth in each valve; laterals nearly or quite wanting; anterior end of the shell much thickened; nacre dull whitish. Marsupium occupying the whole of the outer gills.

Type: *Alasmodonta ambigua* Say, fig. 186.

Subfamily LAMPSILINÆ Ortmann, 1912.

"Inner lamina of inner gills rarely more or less free from the abdominal sac, generally connected with it throughout; supra-anal opening separated from the anal, rarely entirely closed; branchial openings well defined; edge of the mantle in front of the branchial opening smooth to crenulated or with peculiar papillæ or a flap; marsupium rarely formed by the whole outer gill, generally only by or within the posterior part of the outer gill; edge of marsupium, when charged, distending and bulging out beyond the original edge of the gill, generally assuming a beaded appearance; water-tubes simple in the gravid female; glochidium semicircular or semi-elliptic,

without spine, rarely celt-shaped and with two spines; shell heavy or lighter, rounded, or oval to elongate; color of the epidermis rarely dull, mostly bright, with color markings; sculpture of the beak generally double-looped, but often obsolete. more rarely concentric; hinge generally complete, with well developed teeth, which only in rare cases show a tendency to become reduced; sexual differences more or less noticeable in the shell, often very strongly expressed." (Ortmann.)

Key to the genera of *Lampsilinæ*.

1. Male and female shells alike ..... 2.
   Male and female shells different ..... 5.

2. Shell elongate-triangular ..... *Ptychobranchus.*
   Shell rounded-triangular or oval ..... 3.

3. Shell oval, with a medial row of large tubercles ..... *Obliquaria.*
   Shell rounded-triangular, nodulously wrinkled or lachrymose .... 4.

4. Epidermis painted with delicate mottlings on a light ground, beak cavities shallow ..... *Cyprogenia.*
   Epidermis painted with radiating hair-lines, beak cavities deep and compressed ..... *Dromus.*

5. Female shell more or less expanded in the post-basal region ..... 6.
   Female shell slightly swollen just behind the middle of the base ..... *Medionidus.*

6. Dorsal margin winged ..... 7.
   Dorsal margin not winged ..... 8.

7. Pseudocardinals perfect; glochidium celt-shaped, with two spines ..... *Proptera.*
   Pseudocardinals rudimentary; glochidium semicircular, without spines ..... *Paraptera.*

8. Pseudocardinals well developed, complete ..... 9.
   Pseudocardinals divided into irregular laminæ ..... *Glebula.*

9. Shell with a distinct posterior ridge, dorsal-slope smooth ..... 10.
   Shell usually without a distinct posterior ridge, or when distinct, dorsal-slope radiately sculptured ..... 11.

10. Hinge heavy and strong; hinge-plate wide and flat ..... *Plagiola.*
    Hinge delicate; hinge-plate narrow ..... *Amygdalonaias.*

11. Marsupial expansion of the female shell of the same texture as the rest of the shell ..... 12.
Marsupial expansion of the female shell of different texture from the rest of the shell and usually radiately sculptured ..... *Truncilla.*

12. Inner edge of the mantle in front of the branchial opening differentiated with papillæ or flaps..... 13.
Inner edge of mantle in front of branchial opening without papillæ or flaps ..... 16.

13. Shell smooth ..... 14.
Shell strongly sculptured posteriorly.....*Lemiox.*

14. Beak sculpture double-looped ..... 15.
Beak sculpture concentric .....*Carunculina.*

15. Inner edge of mantle in front of branchial opening in female distinctly papillate ..... *Eurynia.*
Inner edge of mantle in front of branchial opening in female with a ribbon-like flap .....*Lampsilis.*

16. Shell inflated, usually higher than long.....*Obovaria.*
Shell subcompressed, longer than high.....*Actinonaias.*

Genus PTYCHOBRANCHUS Simpson, 1900.

Shell triangular, solid, sometimes becoming arcuate in old specimens; umbonal region rather elevated; beak sculpture consisting of faint, somewhat broken ridges, which have a tendency to be doubly looped; posterior

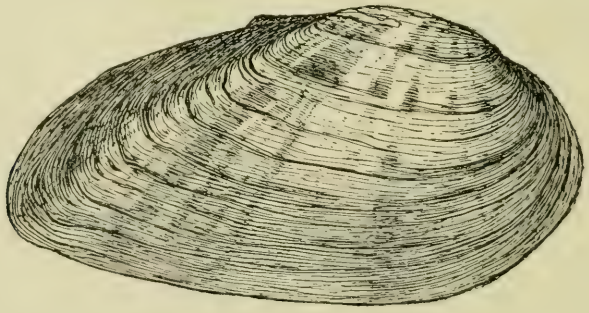


Fig. 187

ridge rounded, but well developed; epidermis usually painted with wavy hair-like rays or broken, radiating bars, which show a tendency to form square spots; hinge-plate rather wide and flat; pseudocardinals small, low, triangular and roughened; laterals club-shaped, remote.

Marsupium occupying the basal half of the entire length of the outer gills and having in front six to twenty beautiful folds; ovisacs distinct, each ending below in an enlarged, rounded bulb, which has a colored spot in the centre.

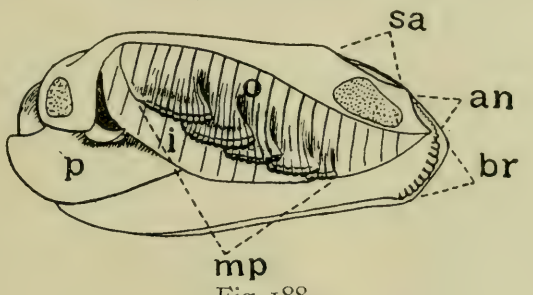


Fig. 188

Type: *Unio phaseolus* Hild., fig. 187. Animal, *P. subtentus* (Say), fig. 188.

Genus OBLIQUARIA Rafinesque, 1820.

Shell inflated, solid, oval, ending in a tolerably sharp point behind, having a row of large, compressed, longitudinal knobs running from the beaks to the centre of the base, those of one valve alternating with the knobs of the other, and a well developed posterior ridge, the space between the ridge and the knobs somewhat excavated; posterior slope and sometimes the entire shell more or less corrugately sculptured; beaks prominent, incurved and pointed slightly forward toward a tolerably well developed lunule; beak sculpture strong, consisting of four or five heavy, parallel ridges, which fall

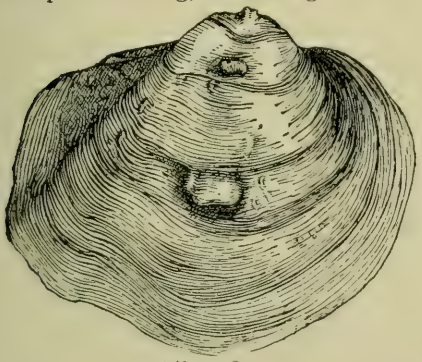


Fig. 189

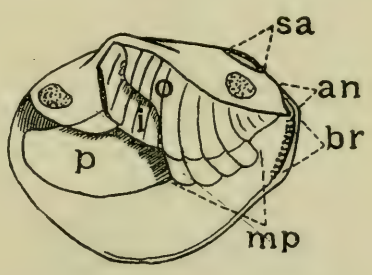


Fig. 190

low in front, but are curved upwards behind; epidermis smooth, generally shining, painted with numerous, delicate, wavy, darker, broken rays; pseudo-cardinals strong, distinct and ragged; laterals short, nearly straight; front part of the shell very solid, suddenly becoming rather thin, just behind the knobs. Marsupium consisting of a few, distinctly marked ovisacs (4 to 7) occupying a position just behind the centre of the outer gills, projecting far below the rest of the branchiæ, their bases rounded.

Type: *O. reflexa* Raf., fig. 189. Animal, fig. 190.

Genus DROMUS Simpson, 1900.

Shell solid, rounded triangular; beaks well forward, rather high; beak sculpture consisting of fine ridges running parallel with the growth lines, the furrows between the ridges interrupted at the posterior ridge; posterior ridge distinct; a series of humps runs from the beaks down to the central part of the base of the shell, which is otherwise sculptured by irregular, concentric ridges; epidermis beautifully painted by undulated, radiating,

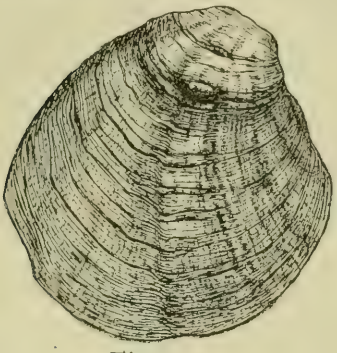


Fig. 191

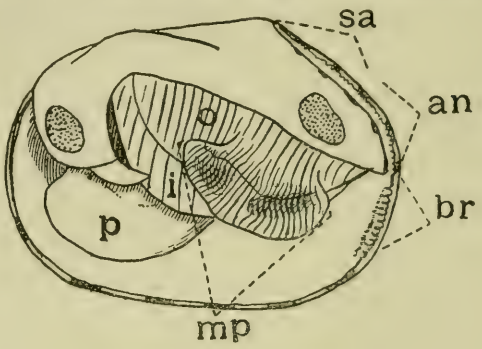


Fig. 192

broken hair-lines or fine maculations; hinge plate wide and flat; pseudocardinals triangular, small and low, ragged; laterals low, short, club-shaped; cavity of the beaks deep and compressed; front part of the shell very thick, suddenly becoming thinner at the row of humps. Marsupium occupying the base of nearly the whole outer gills in numerous narrow ovisacs, which extend beyond the original edge of the gill.

Type: *Unio dromas* Lea, fig. 191. Animal, frontispiece, fig. 192.

Genus CYPROGENIA Agassiz, 1852.

Shell solid, inflated, rounded, triangular, sometimes slightly retuse, generally a little biangular behind; posterior ridge usually well developed; umbonal region flattened parallel with the axis of the shell, sometimes com-

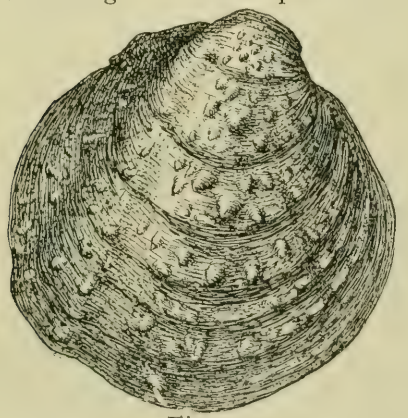


Fig. 193

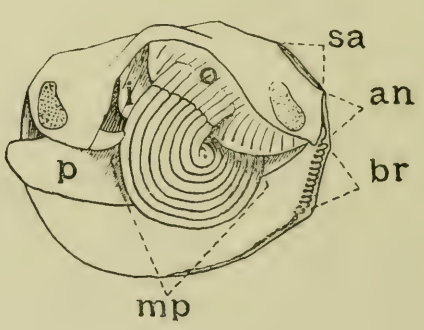


Fig. 194

pressed; beaks curved inward and forward, their sculpture very faint, consisting of slightly double looped ridges; sculpture of the shell nodular, radiately wrinkled or lachrymose; ligament black and conspicuous; lunule distinct, well developed; epidermis shining, painted with a delicate mottling on a light ground; hinge plate wide and flat; pseudo-cardinals heavy, triangular, blunt and ragged; laterals short, obliquely striated, cavity of the beaks not deep; nacre bright and silvery.

Marsupium consisting of from seven to twenty-three very long, purple ovisacs pendant from near the central base of the outer gills and formed into a close coil with the ends turned inward.

Type: *Unio irroratus* Lea, fig. 193. Animal, fig. 194.

Genus PLAGIOLA (Rafinesque, 1819), Agassiz.

Shell solid, surface irregularly, concentrically ridged; epidermis smoothish, but here and there wrinkled; painted with larger and smaller scattered rays, which are generally broken into irregular lunate or squarish blotches;

Fig. 195

hinge heavy and strong; hinge plate wide and flat; female shell smaller than the male, more inflated and swollen at the post basal region. Marsupium large, projecting far below the inner gills.

Type: *Unio securis* Lea, fig. 195.

Genus AMYGDALONAIAS Fischer and Crosse, 1893.

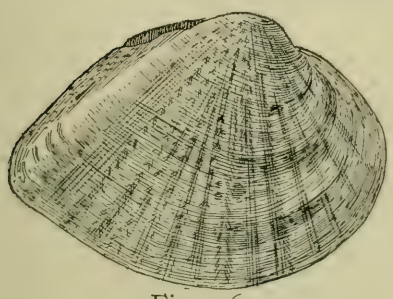


Fig. 196

Shell inflated, decidedly truncate at the posterior slope; surface slightly concentrically sculptured; posterior ridge sharp and well defined; epidermis shining, sometimes wrinkled, looped and painted with a beautiful pattern of broken or arrow-marked rays; area of the beaks flattened off in the direction of the axis of the shell, but not compressed; beak sculpture delicate, somewhat broken and doubly looped, the anterior loop rounded, the posterior sharp below, the ribs fading out where they cross the posterior ridge; hinge

delicate; pseudo-cardinals rather compressed, high and ragged; hinge plate narrow; female shell very slightly swollen at the post-base. Marsupium consisting of numerous, distinct ovisacs and having a well marked sulcus extending around it at some distance above its base.

Type: *Unio cognatus* Lea.

Example: *P. elegans* (Lea), fig. 196.

Genus MEDIONIDUS Simpson, 1900.

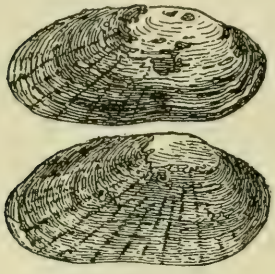


Fig. 197

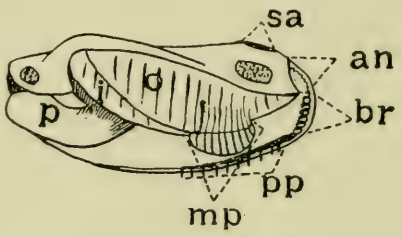


Fig. 198

Shell elongated, rather inflated, often arcuate when adult, sometimes having a posterior ridge; dorsal slope and occasionally the posterior portion of the shell plicately or nodulously wrinkled; epidermis smooth and bright, variagated with broken green rays and blotches; beak sculpture consisting of rather fine, subparallel, often broken ridges in two loops, the anterior rounded, the posterior somewhat angled, occasionally broken into zigzags; pseudo-cardinals small, stumpy and somewhat roughened; laterals rather short, slightly curved and club-shaped; female shell slightly swollen behind the middle of the base. Marsupium occupying the central posterior part of the outer gills, sometimes extending nearly their whole length.

Type: *Unio conradicus* Lea, fig. 197. Animal, fig. 198.

Genus GLEBULA Conrad, 1853.

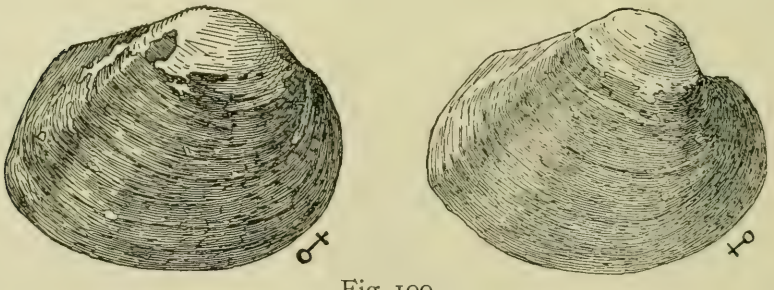


Fig. 199

Shell solid, much inflated, short, elliptical, bluntly pointed and slightly biangulate behind, with a low, posterior ridge; female shell swollen at the

post-base; beaks compressed, sculpture unknown; epidermis brownish, cloth-like; pseudo-cardinals divided into irregularly radiating, granular lamina, sometimes to the number of a dozen or more in each valve; hinge-plate reduced to a mere rounded line behind the pseudo-cardinals; laterals short, remote. Ovisacs apparently separated from each other by a sulcus.

Type: *Unio rotundata* Lam., fig. 199.

Genus PROPTERA Rafinesque, 1819.

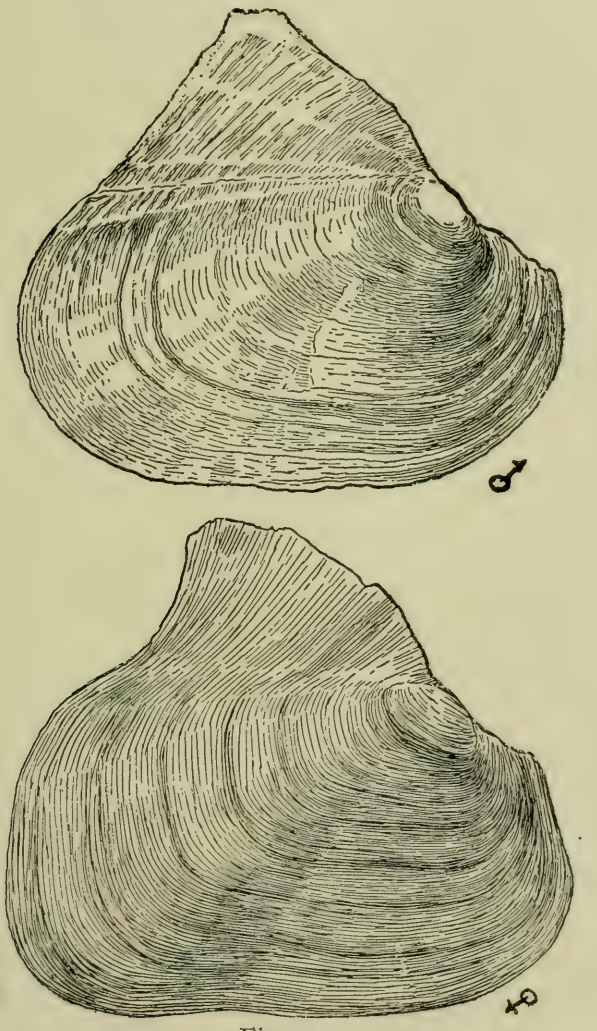


Fig. 200

Shell usually large, gaping at anterior edge and edge of dorsal slope, winged along the dorsal region when young and often when adult; beak

sculpture feeble, consisting, when developed, of an anterior and posterior loop, the former often wanting; epidermis generally brown, often cloth-like when fresh, rayless or feebly rayed; teeth rather compressed, pseudo-cardinals frequently imperfect or nearly wanting; laterals remote. Marsu-

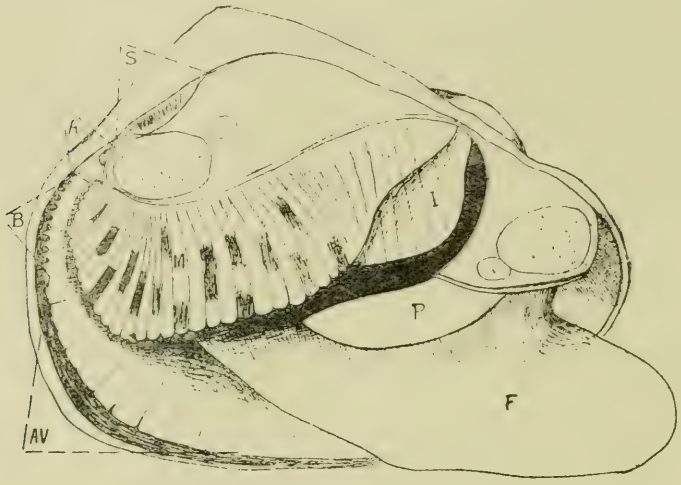


Fig. 201

pium kidney-shaped, consisting of numerous ovisacs occupying the posterior part of the outer gill; edge of mantle in female slightly lamellar in front of the branchial opening with granulations, but without papillæ. Glochidia celt-shaped, with two spines, one at each of the ventral corners.

Type: *Unio alatus* Say, fig. 200. Animal, fig. 201.

Genus PARAPTERA Ortmann, 1911.

Shell large, thin, elliptical or slightly obovate, more or less compressed, winged on the dorsal margin; beaks low; epidermis rather smooth, often feebly rayed, dull colored, but usually glossy; teeth compressed, pseudo-cardinals but feebly and often imperfectly developed; nacre purplish. Male and female shells nearly alike, the latter scarcely swollen at post-basal region.

Marsupium kidney-shaped, swollen, consisting of many ovisacs occupying the posterior part of the outer gill; mantle edge of the female slightly

lamellar in front of the branchial opening, with crenulations, but not with papillæ. Glochidia very small, of suboval shape.

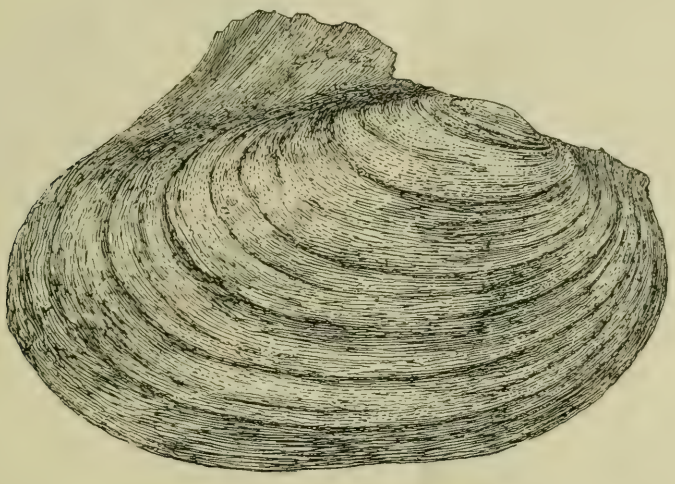


Fig. 202

Type: *Unio gracilis* Bar., fig. 202.

Genus OBOVARIA Rafinesque, 1819.

Shell short, oval, rounded or retuse, solid, inflated, thick in front, thinner behind, with high beaks, which are sculptured with very faint, irregular, often broken and slightly nodulous ridges, which show a tendency to fall into two loops, the posterior often open behind; epidermis dull, brownish, silky or cloth-like, rarely rayed, rays indistinct; female shell but slightly inflated in the post basal region, commonly having a shallow furrow or a flattened area at the posterior end; pseudo-cardinals solid; stumpy; laterals short, club-shaped. Marsupium kidney-shaped, projecting far below the edge of the gill and occupying the posterior portion of the outer gills.

Key to the subgenera of *Obovaria*.

Shell retrorse to short oval, beaks high and central.....*Obovaria s. s.*
Shell elliptical, beaks anterior.....*Pseudoön.*

Subgenus OBOVARIA s. s.

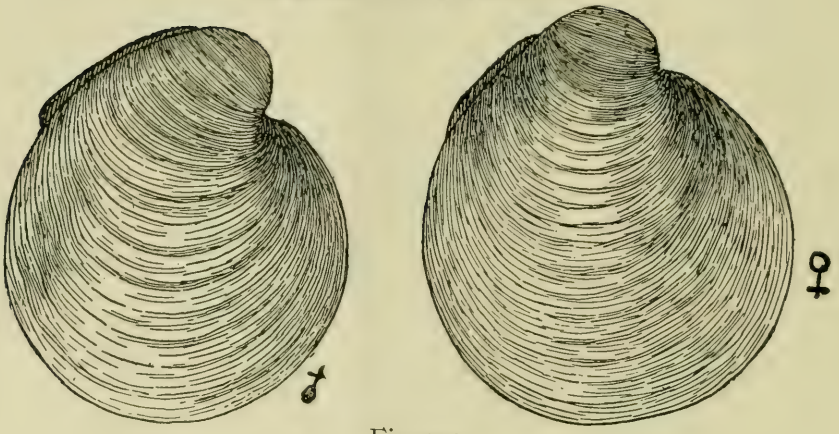


Fig. 203

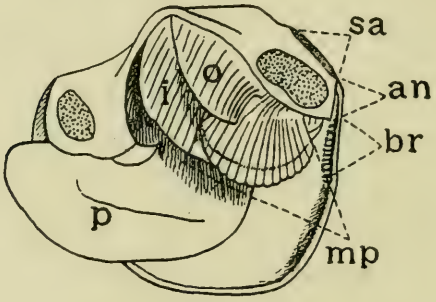


Fig. 204

Shell retrorse to short oval; beaks high, central; pseudo-cardinals rarely parallel with the laterals; cavity of the beaks deep, subcompressed; nacre bluish-white or purple. Marsupium as in the genus.

Type: *Unio retusa* Lam., fig. 203. Animal, fig. 204.

Subgenus PSEUDOÖN Simpson, 1900.

Shell elliptical, inflated, solid; that of the male slightly pointed at the upper posterior part; epidermis brownish or blackish, rayless or very feebly

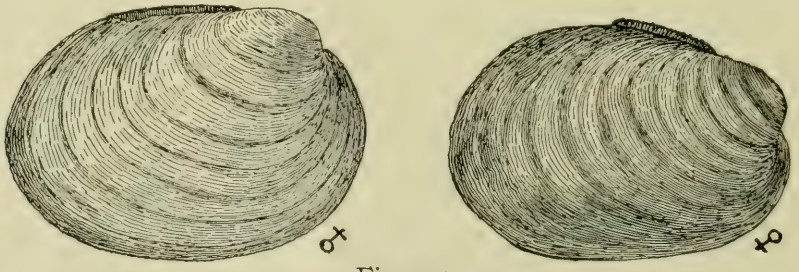


Fig. 205

rayed; beaks anterior; pseudo-cardinals solid, stumpy or slightly elongate in age, and showing a tendency toward being parallel with the laterals; nacre silvery, iridescent posteriorly. Marsupium kidney-shaped, not reaching to the posterior end of the outer gill, though extending quite well forward.

Type: *Unio ellipsis* Lea, fig. 205.

Genus ACTINONAIAS Fischer and Crosse, 1893.

Fig. 206

"Shell ovate or subelliptical, distinctly longer than high, compressed or slightly inflated, without, or with, indistinct posterior ridge. Disk not sculptured. Beaks moderately anterior, never in the middle of the shell and never very near the anterior end. Beak-sculpture poorly developed, consisting of a few faint bars, which have a tendency to become double-looped, with the central part between the loops obliterated. Epidermis yellowish to greenish, generally with distinct rays. Male and female shells differing in shape, but the difference often hardly noticeable.

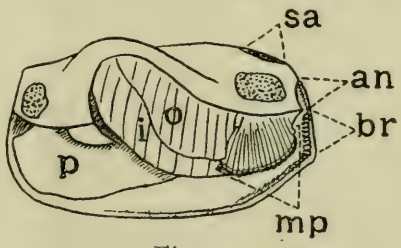


Fig. 207

Soft parts agreeing with those of Obovaria in every respect: the glochidia also of the same type." (Ortmann.)

Type: *Unio sapotalensis* Lea, (animal), fig. 207.

Example: *A. ligamentinus* (Lam.), fig. 206.

Genus CARUNCULINA Simpson, 1898.

Shell small, inflated, obovate, rather solid, with a thick dark epidermis, which is rayless or only feebly rayed; beak sculpture consisting of rather strong, concentric ridges, which form, as a general thing, only a single rounded loop in front and are strongly curved upward behind. Pseudo-

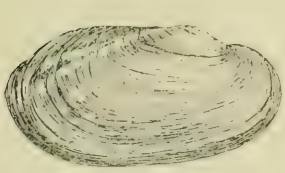


Fig. 208

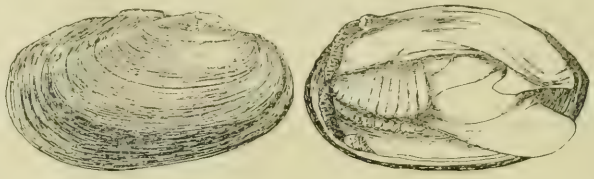


Fig. 209

cardinals compressed, smooth on the inside, generally reflected upward, somewhat torn on the edges. Shell quite commonly pointed posteriorly, that of the female truncated obliquely on the post-base. Marsupium kidney-shaped, formed by a few large ovisacs, projecting beyond the gill; female having a well developed caruncle on the inner edge of the mantle in front of the branchial opening.

Type: *Unio parvus* Bar., fig. 208. Animal, fig. 209.

Genus EURYNIA Rafinesque, 1820.

Shell oval to oblong; surface smooth; beak sculpture delicate, double-looped; female shell more or less expanded or swollen in the post-basal region.

Inner edge of the mantle in the female distinctly papillate. Marsupium kidney-shaped, ocupying the posterior part of the outer gill.

Key to the subgenera of *Eurynia*.

Shell elongate, more or less pointed behind.

Papillæ on inner edge of mantle regular, uniform, reaching to middle of lower margin ..... *Eurynia s. s.*

Shell subovate or subelliptical, not much pointed behind.

Papillæ on inner edge of mantle irregular, not reaching to middle of lower margin ..... *Micromya.*

Subgenus EURYNIA s. s.

Shell usually of good size, subelliptical, elongated, more or less pointed behind; beak sculpture double-looped, the posterior loop often open behind.

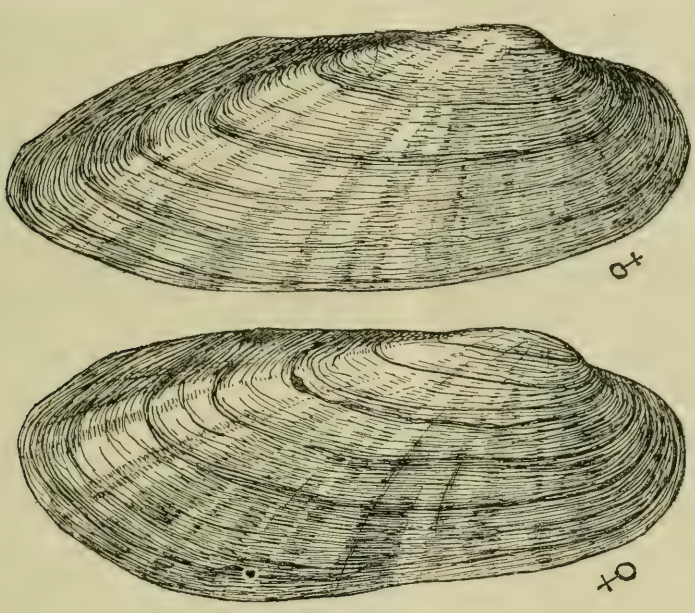


Fig. 210

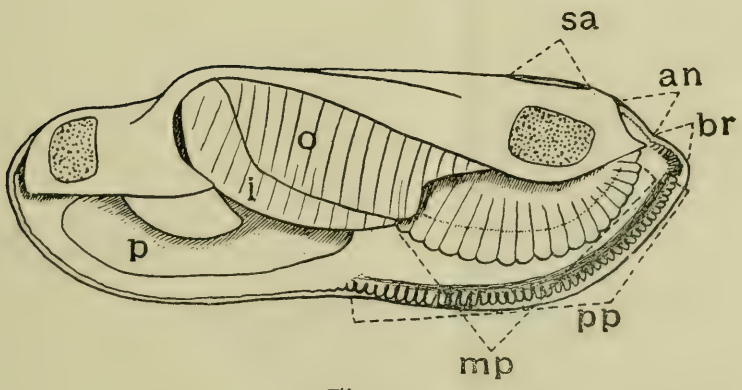


Fig. 211

Inner edge of the mantle in the female in front of the branchial opening with a long row of quite regular, uniform, subequal papillæ, reaching to about the middle of the lower margin.

Type: *Unio recta* Lam., fig. 210. Animal, fig. 211.

Subgenus MICROMYA Agassiz, 1852.

Shell small or of medium size, suboval or subelliptical, not very long and not much pointed behind; beak sculpture distinctly double-looped, but often obsolete, the posterior loop often showing a tendency to be open.

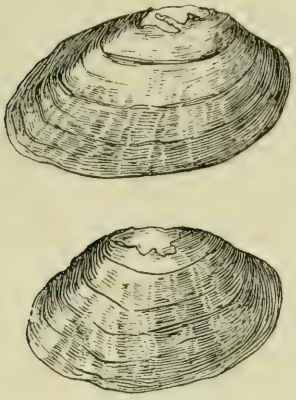


Fig. 212

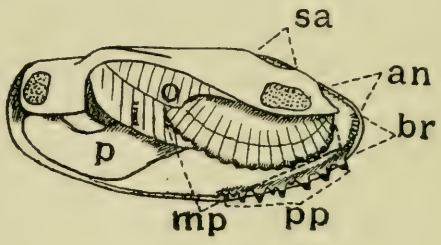


Fig. 213

Inner edge of the mantle of the female in front of the branchial opening with a shorter or longer row of rather irregular, larger and smaller papillæ, reaching not quite to the middle of the lower margin.

Type: *Unio fabalis* Lea, fig. 212. Animal, *E. iris* (Lea), fig. 213.

Genus LAMPSILIS Rafinesque, 1820.

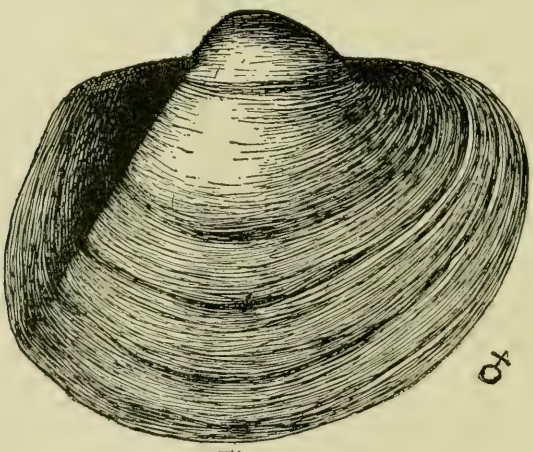


Fig. 214

Shell oval to elliptical, smooth or slightly, concentrically sculptured, usually without a posterior ridge; epidermis generally smooth and shining, often rayed; beak sculpture, consisting of double-looped, parallel ridges, sometimes the posterior loop open behind or the sculpture is obsolete; hinge

with one or two pseudocardinals and one lateral in the right valve, and two pseudo-cardinals and two laterals in the left; female shell having a strong inflation of the shell and dilatation in the post-basal region, producing a distinct posterior truncation of the shell. Marsupium kidney-shaped,

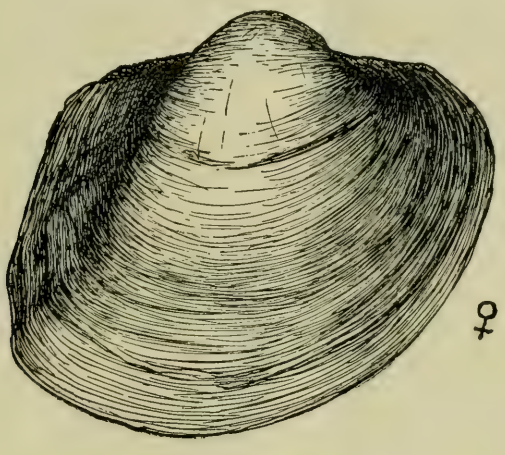


Fig. 214

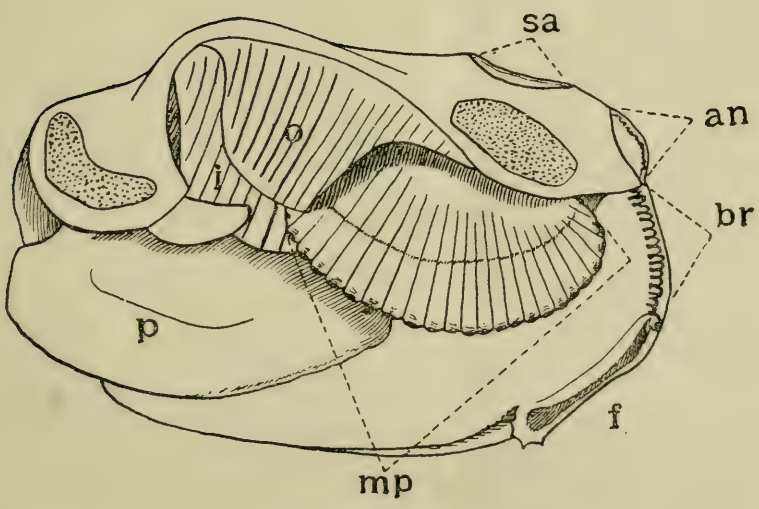


Fig. 215

occupying the posterior part of the outer gills; edge of the mantle of the female in front of the branchial opening developed into a ribbon-like flap, generally produced anteriorly into a full, projecting lobe, which has a lacerated appearance.

Type: *Unio ovatus* Say, fig. 214. Animal, fig. 215.

Genus LEMIOX (Rafinesque ??) Ortmann, 1916.

Shell triangularly ovate, solid, more or less inflated, with a low, rounded posterior ridge; beaks high, turned forward over a small lunule, sculpture distinctly double-looped; surface with strong, corrugated, subradial sculpture on the posterior half, which is divaricate on the posterior ridge and which sometimes covers the entire shell; epidermis clouded, dull-green or yellowish green, usually feebly rayed; pseudocardinals low, subradial, ragged, two in the left valve, one to three in the right valve; laterals heavy, double in the left valve, partly double in the right; muscle scars small, impressed; nacre silvery white, iridescent behind, thicker in front. Male shell subovate or subtriangular, with a broad, shallow, radial depression in front of the posterior ridge or having the whole disk, at least, flattened. Female shell usually ovate, sometimes inflated, smaller than the male, with a feebly developed marsupial swelling, distinctly, but irregularly, denticulate on the margin, at the base near the posterior end.

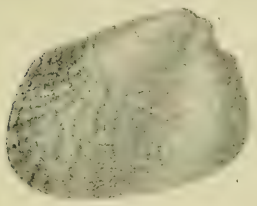


Fig. 216

Mantle margin of the female in front of the branchial opening denticulate on the outer margin. The inner margin has, just in front of the branchial, a few small papillæ and then is laminate and elevated and rather smooth and probably capable of some expansion.

Type: *Unio cælatus* Con. (*Unio rimosus* Raf. ??), fig. 216.

Genus TRUNCILLA Rafinesque, 1819.

Shell rounded, oval or subtriangular, solid, inflated, generally smooth and rayed; beak sculpture delicate, often obsolete, double-looped; female shell very different from that of the male, having a very decided inflation in the post basal region, which is thinner than the rest of the shell, of different texture, often toothed and usually radiately sculptured.

Inner edge of the mantle in the female in front of the branchial opening is not parallel to the outer edge, but is more or less remote from it, often quite distant from it and has finer or coarser papillæ. The mantle between the two edges is peculiarly spongy. Marsupium swollen, kidney-shaped, formed by many ovisacs, occupying the posterior portion of the outer gill.

Key to the subgenera of *Truncilla*.

1. Male shell smooth, no radiate, posterior furrow; female shell inflated along posterior ridge ..... *Truncilla s. s.*
   Male shell with a wide, radiate, posterior furrow ..... 2.

2. Female shell with a small, rounded, radial post-basal swelling ..... *Scalenaria.*
   Female shell with a greatly produced basal swelling, nearly in the centre of the base ..... *Dysnomia.*
   Female shell with a rounded, foliaceous swelling at the posterior base ..... *Pilea.*

Subgenus TRUNCILLA s. s.

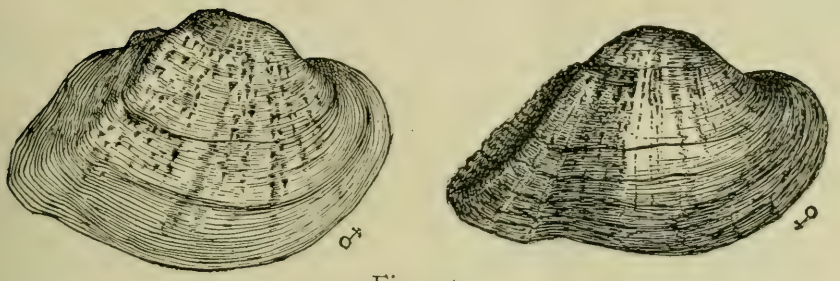


Fig. 217

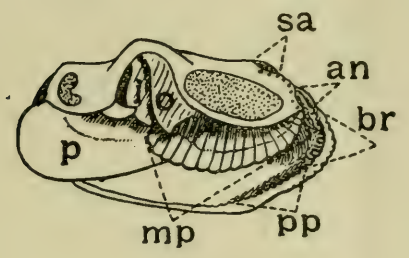


Fig. 218

Shell covered with broken rays, somewhat triangular and without a wide, radiate, posterior furrow.

Type: *T. triqueter* Raf., fig. 217. Animal, fig. 218.

Subgenus SCALENARIA (Rafinesque, 1820) Agassiz.

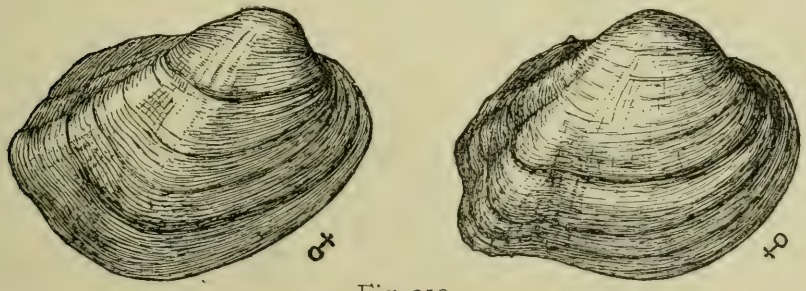


Fig. 219

Male shell having a wide, radiating, shallow depression in front of the posterior ridge; that of the female having a small, rounded, well-defined, radial post-basal swelling.

Type: *Unio sulcatus* Lea, fig. 219.

Subgenus DYSNOMIA Agassiz, 1852.

Shell of the male with a posterior and central radiating ridge, with a wide flattened space between, that of the female with a greatly produced

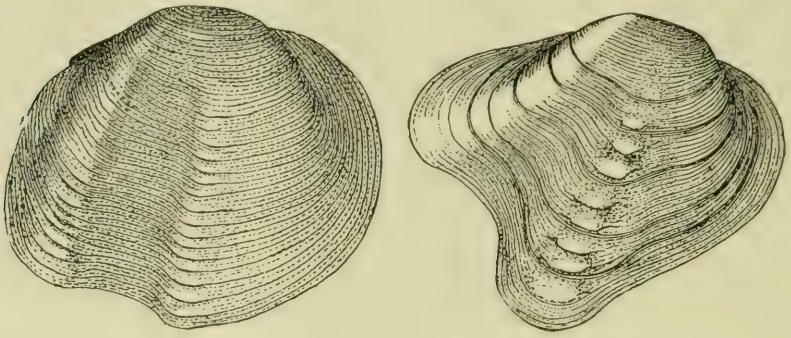


Fig. 220

inflation a little behind the centre of the base, being a continuation of the central ridge.

Type: *Unio foliatus* Hild., fig. 220.

Subgenus PILEA Simpson, 1900.

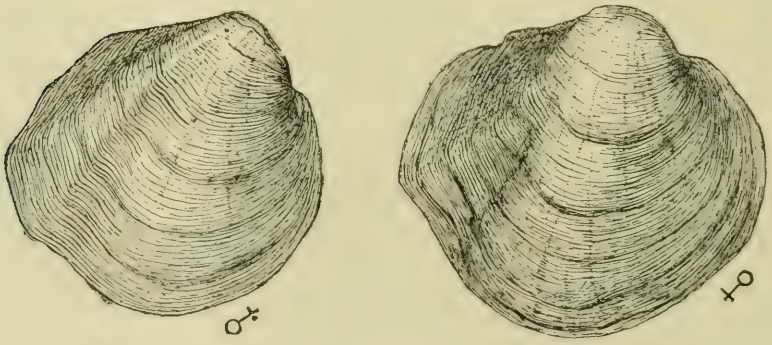


Fig. 221

Male shell with a wide, shallow, radiating depression in front of the posterior ridge, that of the female with a rounded foliaceous swelling at the posterior base.

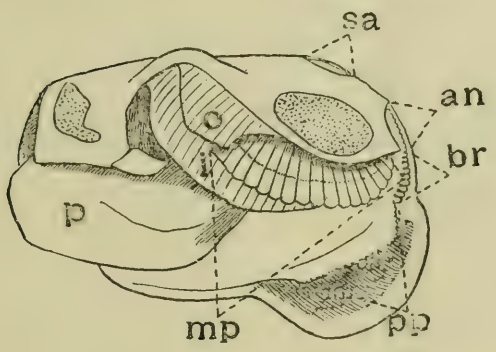


Fig. 222

Type: *Unio personatus* Say, fig. 221. Animal, *T. rangiana* (Lea), fig. 222.

Genus *incertæ sedis.*

Genus COKERIA Marshall, 1916.

"Shell gaping anteriorly, moderately thin, subquadrangular to subtriangular; abruptly rounded anteriorly, posterior margin nearly straight and perpendicular, dorsal margin straight, ventral margin gently curving throughout its entire length. Valves widest just in front of the posterior ventral angle. Umbones at about the anterior third of the dorsal margin,

Fig. 223

high and incurved, the second growth line nearly horizontal. Posterior dorsal ridge very high, obtusely angular. Posterior area descending abruptly from the ridge and somewhat wing-like. Greatest inflation is along the umbonal ridge. A pronounced furrow extends from the umbo to the lower third of the posterior margin. Seven rest periods distinctly marked by con-

centric dark lines. Anteriorly from the middle portion a bold rounded rib occurs just below each rest-period. Dorsal area faintly radiately striate. Color, varying shades of chestnut, lighter (nearly straw color) anteriorly, darker posteriorly, rest stages sharply defined by blackish lines. Umbonal region faintly tinged with green. Periostracum thin, slightly glossy, closely adhering.

"Nacre anteriorly lustrous white and thickened; posteriorly thin violaceous and brilliantly iridescent. Pallial line not sharply defined and with several concentric striæ above it, its anterior portion radiately striated. Anterior adductor and retractor scars separated, deep and rough, posterior scars superficial. Dorsal scars concealed by the incurving of the upper portion of the valve.

"Lateral tooth of the right valve thin, very high, wing-like, striated longitudinally. Laterals of the left valve similar to that of the right valve, but smaller, the groove between them being very narrow. Pseudocardinals of the right valve two, thin, opposite, the upper one being the stronger. Pseudocardinals of the right (left?) valve coalescing, standing in the same straight line, the anterior one high, slightly curved, the posterior low, its summit irregularly crenulated. The sculpture of each umbo consists of four concentric ridges, highest (almost a nodule) at their posterior ends, and numerous concentric striæ." (Marshall).

Type: *Cokeria southalli* Marshall, fig. 223.

Family DREISSENSIIDÆ.

Shell mytiliform, equivalve, of prevailing prismatic substance, ligament subinternal; anterior adductor and pedal protectors inserted on a septum in the beak. Byssiferous.

Genus CONGERIA Partsch, 1835.

Type: *Congeria subglobosa* Partsch.

Typical Congeria is not represented in our fauna.

Subgenus MYTILOPSIS Conrad, 1857.

Shell mytiliform, attached by a byssus; hinge with a septum, beneath which on the cardinal side is a triangular cup-shaped, thin, white process, which projects obliquely towards the cavity of the valves; cartilage groove rather deep. Edge of the mantle united and extended posteriorly in two distinct siphons and open on the base for the extension of the foot.

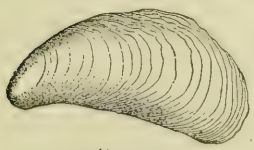


Fig. 224

Type: *Mytilus leucophæatus* Con., fig. 224.

Family CYRENIDÆ.

Shell porcellanous, thick, solid, hinge-plate developed, teeth strong, prominent; equivalve; ligament external. Siphons distinctly developed; dicœcious.

Genus CYRENA Lamarck, 1818.

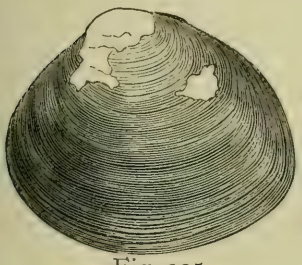


Fig. 225

Shell oval or subtrigonal, thick, solid, cardinal teeth, three in each valve; two anterior and two posterior laterals in the right valve and one anterior, and one posterior in the left; pallial line (in the American species, Section *Polymesoda* Rafinesque, 1820) with a deep, narrow sinus.

Type: *C. bengalensis* Lam.

Type: Section *Polymesoda, Cyclas caroliniana* Bosc., fig. 225.

Family SPHÆRIIDÆ.

Shell small and thin, ligament feeble, short; pallial line simple; no hinge plate; cardinal teeth usually two in each valve; laterals four in the right valve, two anterior and two posterior and two in the left, one anterior and one posterior; foot long, narrow, grooved, byssiferous when young; monœcious; the young incubated in a marsupium formed by the inner gill.

Key to the genera of *Sphæriidæ*.

1. Shell nearly equilateral; beaks subcentral ..... 2.
   Shell inequilateral; beaks terminal ..... *Pisidium.*

2. Nepeonic valves not distinctly separated from the subsequent growth of the shell ..... 3.
   Nepeonic valves inflated, separated from the adult growth by a distinct sulcus ..... *Musculium.*

3. Shell oval, cardinal teeth, two in each valve ..... *Sphærium.*
   Shell rhomboidal, one cardinal tooth in each valve ..... *Eupera.*

Genus SPHÆRIUM Scopoli, 1777.

Shell thin, oval, more or less inflated; subequilateral, beaks subcentral; surface smooth or concentrically striate, teeth small, cardinals two in each valve, lateral teeth double in the right, single in the left valve. Siphons united at the base, but double at the extremity.

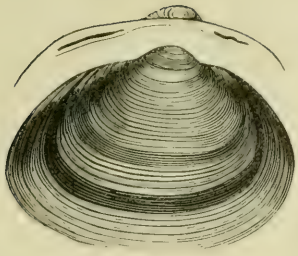


Fig. 226

Shell oval, relatively thick, nepeonic-shell passing into the adult without any distinct demarcation; anterior end shorter; surface usually concentrically striate or sulcate; cardinal teeth small but distinct.

Type: *Tellina cornea* L.

Example: *S. sulcatum* (Lam.), fig. 226. Animal, fig. 227.

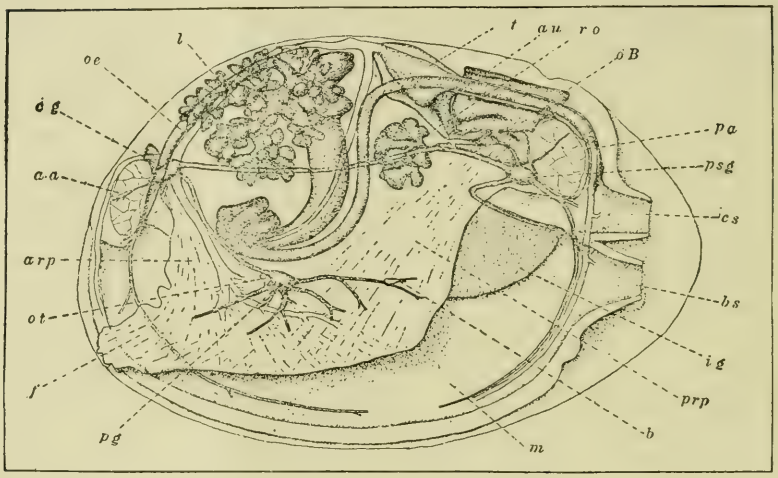


Fig. 227

aa.—Anterior adductor muscle.
ao.—Anterior aorta.
arp.—Ant. retractor pedis muscle.
as.—Ant. adductor muscle scar.
au.—Auricle.
b.—Byssal gland rudiment.
bls.—Blood space.
bs.—Branchial siphon.
c.—Cloacal chamber.
cg.—Cerebral ganglion.
cr.—Chitinous rods.
cs.—Cloacal siphon.
f.—Foot.
fil.—Gill filament.
ifj.—Inter-filamentar junctions.
ig.—Inner gill.
io.—Inhalent ostea.
l.—Liver.
lp.—Labial palpus.
m.—Mantle.
oB.—Organ of Bojanus.
oe.—Œsophagus.
og.—Outer gill.
ot.—Otocyst.
ov.—Ovarian follicle.
p.—Pericardial cavity.
pa.—Posterior adductor muscle.
pg.—Pedal ganglion.
prp.—Post. retractor pedis muscle.
ps.—Post. adductor muscle scar.
psg.—Parieto-splanchnic ganglion.
r.—Mantle ridge.
ro.—Reproductive organs.
t.—Male follicle.
vt.—Ventricle.
wt.—Water-tube.

Genus MUSCULIUM Link 1807.

Fig. 228

Shell thin, suborbicular or oblong, smooth, shining, striæ very fine and delicate; beaks calyculate; cardinal teeth minute, often obsolete.

Type: *Tellina lacustris* Müll.

Example: *M. jayanum* (Pme.), fig. 228. Animal, *M. truncatum* (Lins.), fig. 229.

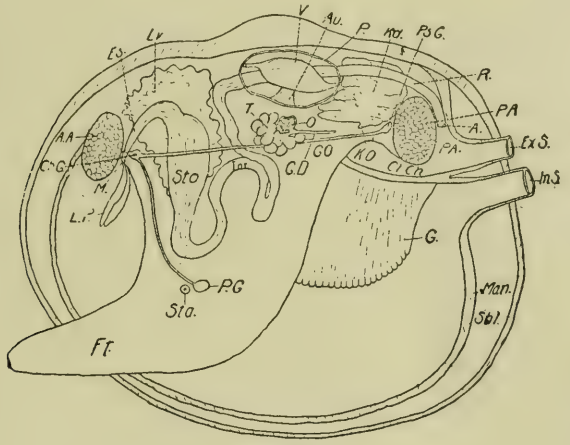


Fig. 229

M.—Mouth.
Lp.—Labial palps.
Es.—Oesophagus.
Lv.—Liver.
Sto.—Stomach.
Int.—Intestine.
R.—Rectum.
A.—Anus.
CbG.—Cerebral ganglion.
PsG.—Parieto-splanchnic ganglion.
PG.—Pedal ganglion.
Sta.—Statocyst.
V.—Ventricle.
Au.—Auricle.
Pl.—Pericardium.
KO.—Kidney opening.
T.—Sperm follicles.
O.—Egg follicles.
GD.—Genital opening.
AA.—Ant. adductor muscle.
PA.—Post. adductor muscle.
Ft.—Foot.
ClCh.—Cloacal chamber.
ExS.—Excurrent siphon.
InS.—Incurrent siphon.
G.—Gill.
Man.—Mantle.
Shl.—Shell.
Kd.—Kidney.

Genus EUPERA Bourguignat, 1854.

Fig. 230

Shell subrhomboidal. Moderately inflated, thin, with the posterior side longer; cardinal teeth feeble, one only, in each valve. Animal as in *Sphærium*.

Type: *Pisidium moquinianum* Bgt.

Example: *E. singleyi* (Pils.), fig. 230.

Genus PISIDIUM C. Pfeiffer, 1821.

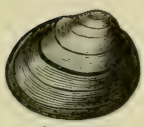


Fig. 231

Shell small, rounded, oval or obliquely cuneiform; inequilateral, anterior side longer; beaks terminal; cardinal teeth double in each valve, at times united, situated immediately under the beaks; laterals elongated, lamelliform, double in the right, single in the left valve; ligament on the shorter side, internal.

Animal with a single siphon, the excurrent orifice being merged with that of the foot.

Type: *Tellina amnica* Müll.

Example: *P. virginicum* (Gmel.), fig. 231.

Family CYRENELLIDÆ.

Shell rounded, inflated, thin, with a conspicuous epidermis; beaks forward; cardinal teeth two on the right and one on the left valve; no lateral teeth; pallial line not sinuate. Animal with two contractile siphons, elongated and united to their tips.

Genus CYRENELLA Deshayes, 1835.

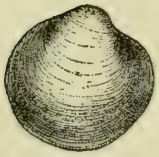


Fig. 232

Shell as in the family, surface smooth or slightly concentrically sculptured.

Type: *Cyrenoidea dupontiæ* Joannis.

Example: *C. floridana* (Dall), fig. 232.

Family RANGIIDÆ.

Shell equivalve, covered with an epidermis, no internal nacre; beaks prominent, separated; hinge with two cardinal and anterior and posterior lateral teeth in each valve and an internal, central cavity for the ligament; pallial line sinuous. Mantle with two short siphons united at their bases and with papillose orifices; foot large, linguiform, compressed.

Genus RANGIA Desmoulins, 1832.

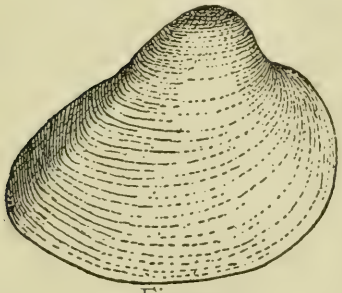


Fig. 233

Shell thick, oval, subtrigonal, ventricose, smooth, epidermis olive, beaks prominent, separated; ligament and resilium both enclosed in a single pit and invisible externally; laterals curved, cross-striated, more or less unequal, the posterior longer, anterior with the proximal end vertically hooked; pallial sinus small.

Type: *Gnathodon cuneatus* Gray, fig. 233.

UNIVERSITY OF MICHIGAN

MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 6

A Synopsis of the Classification of the Fresh-Water Mollusca of North America, North of Mexico,

AND

A Catalogue of the More Recently Described Species, With Notes

BY

BRYANT WALKER

PART II—CATALOGUE

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
DECEMBER 30, 1918

A CATALOGUE OF THE MORE RECENTLY DESCRIBED FRESH-WATER MOLLUSCA OF NORTH AMERICA, WITH NOTES

Subclass EUTHYNEURA.

Order PULMONATA.

Suborder BASOMMATOPHORA.

Superfamily LIMNOPHILA.

Family LYMNÆIDÆ.

Genus LYMNÆA Lamarck, 1788.

Baker's elaborate monograph of the *Lymnæidæ* of North America (No. 6) brings the subject down to 1911.

Simpsonia having been used by Rochebrune in 1904 for a group of Naiades, Baker (7, p. 120) has substituted *Pseudogalba* for his Lymnæid group. The synonymy will be as follows:

Simpsonia Baker, Chi. Acad. Sci., Sp. Pub. 3, 1911, p. 236. *Non* Rochebrune, 1904.

Pseudogalba Baker, Naut. XXVI, 1913, p. 120.

For a proposed revision of Baker's arrangement and key, see Colton (22, p. 116 and 23, p. 119) and reply by Baker (8, p. 20).

For the author's arrangement, see ante p. 6.

Lymnæa apicina Lea.

Although Lea's name *solida* for this species has page precedence as stated by Hannibal (53, p. 146), and has been preferred by Haldeman, Tryon and Binney, according to Kuster (Con. Cab., Lymnæus, p. 48) *solida* Phil. has priority and Lea's species must be known by the later name.

Lymnæa auricularia (L.).

This species seems to have become thoroughly acclimated and is extending its range in this country very rapidly. In addition to the localities cited by Baker (6, p. 182), it has been listed from Toledo, O., by Goodrch (47, p. 11); Lake Erie, Kingsville, Ont., by Allen (1, p. 60); Philadelphia, Pa., by Long (72, p. 27); Colorado Springs, Colo., by Henderson (55, p. 84); Charles River, Cambridge, Mass., by Clapp (19, p. 116) and Johnson (59, p. 83) and has more recently been found in the Detroit River at Belle Isle by Dr. H. B. Baker and at Gibralter, Wayne Co., and La Plaisance Bay, Monroe Co., by Goodrich and at Harbor Beach, Huron Co., Mich., by Walter Koelz.

LYMNÆA COOPERI Hannibal.

Lymnæa Cooperi Hannibal, Proc. Mal. Soc. Lond., X, 1912, p. 143, pl. VI, fig. 13a — c.
Type locality: Spring at Wright's, Santa Cruz Mountains, Cal.

LYMNÆA MONTANENSIS Baker.

Lymnæa montanensis Baker, Naut., XXVI, 1913, p. 115.
Type locality: Hayes' Creek, Ward, Montana.

Family PLANORBIDÆ.

Subfamily PLANORBINÆ H. and A. Adams, 1858.

Genus PLANORBIS Müller, 1774.

Dr. Dall (32, p. 80) has proposed the following arrangement of this genus:

Subgenus *Planorbis* s. s.
Type *Planorbis corneus* Müller.

Section *Planorbina* Haldeman.
Type *P. olivaceus* Spix.

Subgenus *Helisoma* Swainson.
Type *P. bicarinatus* (Say) Sowerby.

Section *Pierosoma* Dall.
Type *P. trivolvis* Say.

Section *Planorbella* Haldeman.
Type *P. campanulatus* Say.

Subgenus *Tropidiscus* Stein.
Type P. *umbilicatus* Müller.

Subgenus *Hippeutis* Agassiz.
Type *P. fontanus* Lightfoot.

Section *Menetus* H. and A. Adams.
Type *P. opercularis* Gould.

Subgenus *Gyraulus* Agassiz.
Type *P. albus* Müller.

Section *Torquis* Dall.
Type *P. parvus* Say.

Section *Armiger* Hartmann.
Type *P. crista* L.

For a criticism of Dall's arrangement, see Kennard (64, p. 47) and reply by Dall (33, p. 141).

Brown and Pilsbry have proposed (15, p. 212) a new section, *Tropicorbis,* type *P. liebmanni* Dkr., but without any definition.

PLANORBIS ALABAMENSIS Pilsbry.

Planorbis alabamensis Pilsbry, Naut., VIII, 1895, p. 114.
Type locality: Woodville, Ala.

Dall (32, p. 92) considers this a local race of *dilatatus* Gld., but it seems sufficiently distinct.

PLANORBIS ALABAMENSIS AVUS Pilsbry.

Planorbis alabamensis avus Pilsbry, Naut., XIX, 1905, p. 34.
Type locality: Caloosahatchee Pliocene, Fla. Also from the marl at Lake Panasoffkee, Fla.

PLANORBIS ANTROSUS Conrad.

Vanatta has shown (138, p. 138) that as the earliest available name this must take precedence over the familiar *P. bicarinatus* Say, *non* Lamarck, 1804.

Conrad's type has disappeared and until topotypes can be obtained, the uncertainty as to whether Conrad's species is typical *bicarinatus* Say or equivalent to var. *angistomus* Hald. prevents the proper re-arrangement of the forms.

According to Vanatta (l. c.) *P. bicarinatus major* and *bicarinatus minor* of Beck (Index. Moll., 1837, p. 118) are synonyms of the typical form.

Planorbis biangulatus Say., Con. Icon., Planorbis, 1877, Sp. 25, pl. IV, fig. 25, said to be from Brazil is apparently this species.

PLANORBIS ANTROSUS ANGISTOMUS Haldeman.

Planorbis bicarinatus angistomus Haldeman, Mon., 1844, p. 7; Walker, Naut, 1909, XXIII, p. 4, pl. II, fig. 4-5.
Type locality not given.

PLANORBIS ANTROSUS AROOSTOOKENSIS Pilsbry.

Planorbis bicarinatus aroostookensis Pilsbry, Naut., VIII, 1895, p. 115; Walker, Naut., 1909, XXIII, p. 7, pl. I, fig. 1 & 3.
Type locality: Salmon Brook, Woodland, Aroostook Co., Me.

PLANORBIS ANTROSUS CORRUGATUS Currier.

Planorbis bicarinatus corrugatus Currier MSS, DeCamp, Kent Sci. Inst. Misc. Pub., 1868, p. 8; Walker, Naut., XXIII, 1909, p. 5, pl. I, fig. 10.
Type locality: Perch Lake, Kent Co., Mich.

PLANORBIS ANTROSUS PERCARINATUS Walker.

Planorbis bicarinatus major Walker, Naut., VI, 1893, p. 136.
Planorbis bicarinatus percarinatus Walker, Naut., XXIII, 1909, p. 6, pl. I, fig. 12.
Type locality: Crystal Lake, Benzie Co., Mich.

PLANORBIS ANTROSUS PORTAGENSIS Baker.

Planorbis bicarinatus portagensis Baker, Naut., XXII, 1908, p. 45; Walker, Naut., 1909, XXIII, p. 8, pl. I, fig. 9.
Type locality: Portage Lake, Aroostook Co., Me.

PLANORBIS ANTROSUS ROYALENSIS Walker.

Planorbis bicarinatus royalensis Walker, Naut., XXIII, 1909, p. 9, pl. I, fig. 11.
Type locality: Siskowit Lake, Isle Royale, Mich.

PLANORBIS ANTROSUS STRIATUS Baker.

Planorbis bicarinatus striatus Baker, Naut., XV, 1902, p. 120; Tr. Acad. Sci. St. Louis, 1906, XVI, p. 9, pl. I, fig. 11.
Type locality: Coldspring Park, Milwaukee, Wis. Also recent.
See Walker 151a, p. 7.

PLANORBIS ANTROSUS UNICARINATUS Haldeman.

Planorbis bicarinatus unicarinatus Haldeman, Mon., 1844, p. 7; Walker, Naut., XXIII, 1909, p. 3, pl. I, fig. 6-8.
Type locality: Schuylkill River, Pa.

PLANORBIS ARCTICUS Möller.

Planorbis arcticus Möller, Index Moll. Grönl., 1842, p. 5; Morch, Am. J. of Con., 1868, IV, p. 32, pl. 4, fig. 9.
Type locality: Kudsuk, Greenland. Also Fort Chimo, Ungava, Labrador.

PLANORBIS ARIZONENSIS Pilsbry and Ferriss.

Planorbis filocinctus Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 165, pl. IX, figs. 1-3, not of Sandberger.
Planorbis arizonensis Pilsbry and Ferriss, Pr. A. N. S. P., 1915, p. 390.
Type locality: San Pedro River, Benson, Ariz.

PLANORBIS BILLINGSI Lea.

Planorbis billingsi Lea, Pr. A. N. S. P., 1864, p. 111; Jour. A. N. S. P., 1866, VI, p. 15, pl. 23, fig. 72; Obs., 1866, XI, p. 115, pl. 23, fig. 72.
Type locality: Ottawa River, Canada. See *parvus*.

PLANORBIS CALLIOGLYPTUS Vanatta.

Planorbis callioglyptus Vanatta, Naut., IX, 1895, p. 54.
Type locality: Freeport, Wash.
Is *opercularis planulatus* Cooper according to Dall (32, p. 92).

Planorbis campanulatus minor Dunker.

Planorbis campanulatus minor Dunker, Con. Cab., 1850, Limnæiden, p. 52, pl. 9, fig. 10.
Type locality not given.

Planorbis campanulatus rudentis Dall.

Planorbis campanulatus rudentis Dall, Rep. Harriman Exp., 1905, XIII, p. 90.
Type locality: Knee Lake, Keewatin, Canada.

The citations of *P. multivolvis* from Newfoundland by Farrar (37, p. 36), and from Michigan by Walker, prior to 1907, refer to this form and not to Case's species.

Planorbis campanulatus smithii Baker.

Planorbis campanulatus smithii Baker, Naut., XXV, 1912, p. 118.
Type locality: Douglas Lake, Cheboygan Co., Mich.

Planorbis caribæus d'Orbigny.

This name has priority for the species commonly known as *tumidus* Pfr.

Planorbis carus Pilsbry and Ferriss.

Planorbis carus Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 164, pl. IX, figs. 4-5.
Type locality: Canyon of the Pecos River, above High Bridge, Val Verde Co., Texas.

Planorbis centervillensis Tryon.

Planorbis centervillensis Tryon, Mon., 1870, p. 210, pl. 7, fig. 7-9.
Type locality: Centerville, Cal.

Is a form of *opercularis* according to Dall (32, p. 92).

Planorbis circumstriatus Tryon.

Planorbis circumstriatus Tryon, Am. J. of Con., II, 1866, p. 113, pl. 10, figs. 6-8.
Type locality: Weatogue, Conn.

As identified by Sterki, this species is certainly distinct from *P. parvus* Say. It ranges from Connecticut to Colorado.

Planorbis coarctatus Sowerby.

Planorbis coarctatus Sowerby, Con. Icon., Planorbis, 1876, Sp. 21, pl. 3, fig. 21 a-b.
Type locality:?

This is apparently an immature *campanulatus*.

PLANORBIS COMMUTATUS "Dunker" Sowerby.

Planorbis commutatus Sowerby, Con. Icon., Planorbis, 1876, Sp. 63, pl. 8, fig. 63.
Type locality: North America.

PLANORBIS CORPULENTUS Say.

Is a valid species. See Walker 144, p. 133. The citation of this species from Florida or South Carolina by Melvill (74, p. 167) is no doubt erroneous. Sowerby's figures of this species in the Conchologia Iconica are *binneyi* Tryon.

PLANORBIS CRISTA L.

Planorbis nautileus, Walker, Naut., 1897, X, p. 117; Hanham, Naut., 1897, X, 130; Taylor, Naut., 1897, X, p. 139.
Planorbis costatus DeTarr and Beecher, Leaflet, Albany, 1878; Baker, Naut., 1906, XIX, p. 120.
Range: Maine, west to Alberta and Illinois.

PLANORBIS CULTRATUS Orbigny.

Planorbis cultratus Orbigny, Hist. Cuba Moll., 1853, (Fr. ed.) I, p. 196, pl. 14, figs. 5-8; Pilsbry, Naut., 1889, III, p. 63, pl. I, fig. 1-3.
Type locality: Cuba?

Listed from Miami, Fla., by Rhoads (113, p. 48) and by Pilsbry from Hidalgo, Tex. (88, p. 63) and by Pilsbry and Ferriss from Devil's River, Val Verde Co., Tex. (106, p. 165).

PLANORBIS DECLIVIS Sowerby.

Planorbis declivis Sowerby, Con. Icon., Planorbis, 1876, Sp. 28, pl. 4, fig. 29.
Type locality: ?

Von Martens (73, p. 397) thinks that this is probably a form of *trivolvis*. The name is pre-occupied by Tate (1870), for a species from Nicaragua.

PLANORBIS DEFLECTUS Say.

Planorbis deflexus Sowerby, Con. Icon., Planorbis, 1876, Sp. 88, pl. XI, fig. 88.

Dall (32, p. 94) considers this doubtfully distinct from *hirsutus* and apparently identical with the European form known as *draparnaudi* or *draparnaldi* Shepp.

PLANORBIS DILATATUS Gould.

Includes *buchanensis* Lea according to Tryon (132, p. 209); *virens* and *elevatus* according to Vanatta (136, p. 55); and *lens, alabamensis* and *buchanensis* according to Dall (32, p. 92).

PLANORBIS DILATATUS PENNSYLVANICUS Pilsbry.

Planorbis dilatatus pennsylvanicus Pilsbry, Naut., XXX, 1916, p. 96.
Type locality: Glenolden, Delaware Co., Pa.

PLANORBIS DURYI Wetherby.

Planorbis duryi Wetherby, Jour. Cin. Soc. Nat. Hist., 1879, p. 7, fig. 4.
Type locality: Everglades, Fla. Types No. 9712 Coll. Walker.

PLANORBIS DURYI INTERCALARIS Pilsbry.

Planorbis duryi intercalaris Pilsbry, Amer. Nat., 1887, XXI, p. 287.
Planorbis intercalaris Rhoads, Naut., 1899, XIII, p. 47.
Type locality: Florida.

PLANORBIS EUCOSMIUS Bartsch.

Planorbis eucosmius Bartsch, Pr. U. S. Nat. Mus., 1908, XXXIII, p. 699, pl. 57, figs. 1-3.
Type locality: Greenfield Pond, Wilmington, N. C.

PLANORBIS EUCOSMIUS VAUGHANI Bartsch.

Planorbis eucosmius vaughani Bartsch, Pr. U. S. Nat. Mus., XXXIII, 1908, p. 699, pl. 57, figs. 4-6.
Type locality; Burkes Place, La.

PLANORBIS EXACUOUS Say.

Commonly known as *exacutus* Say, but Dall (32, p. 91) restores the name as originally used by Say. Henderson and Daniels (56, p. 56), after careful consideration, have done likewise. It includes *buchanensis* Lea according to Vanatta (*fide* Simpson) (136, p. 54).

PLANORBIS EXACUOUS MEGAS Dall.

Planorbis exacuous megas Dall, Rep. Harriman Exp., XIII, 1905, p. 91.
Type locality: Birtle, Manitoba.

PLANORBIS GLABRATUS Say.

Haldeman's and Binney's figures do not represent this species, which is entirely distinct from *trivolvis*. It is not uncommon in Florida and in the United States does not range outside of that state, (Pilsbry, 91, p. 321). Dall (32, p. 86) includes *lentus*, which was described from New Orleans, but this does not accord with Fischer and Crosse's (38, p. 65) identification of Say's type. The true *glabratus* belongs to section *Planorbina* and not to *Pierosoma*.

PLANORBIS GRACILENTUS Gould.

Tryon (132, p. 192) and Fischer and Crosse (38, p. 72) consider this distinct from *liebmanni,* to which it is referred by Binney.

PLANORBIS HAVANENSIS Pfeiffer.

Listed from New Orleans, La., as a *Segmentina* by Pilsbry (85, p. 20) and Hinkley (58, p. 36).

PLANORBIS HIRSUTUS Gould.

Is considered distinct from *albus* Müll. by Vanatta (136, p. 55). Dall (32, p. 94) refers it to the so-called *albus* Müll., but in view of the uncertainty as to the proper name to be used for that species, retains Gould's name. Kennard (64, p. 49) considers the American and European species as distinct.

PLANORBIS HIRSUTUS BOREALIS Westerlund.

Planorbis borealis Westerlund, Mal. Bl., XXII, 1875, p. 77.
Type locality: Port Clarence, Alaska; Northern Sweden.

Stated by Dall (32, p. 94) to be "merely a somewhat delicately sculptured mutation."

PLANORBIS HORNI Tryon.

Planorbis horni Tryon, Am. J. of Con., I, 1865, p. 231, pl. 22, fig. 16.
Type locality: Fort Simpson, British America.

Listed as a var. of *trivolvis* by Pilsbry (95, p. 65). Dall (32, p. 89) states that there is a doubt as to whether the types came from Fort Simpson on the Mackenzie River, or Fort Simpson, British Columbia, but that the figure looks more like the Pacific variety (*subcrenatus*), which he refers to *trivolvis.*

PLANORBIS INTERTEXTUS Sowerby.

Planorbis intertextus Sowerby, Con. Icon., Planorbis, 1876, Sp. 123, pl. 14, fig. 123a-b.
Type locality: Florida.

Through the courtesy of Mr. E. A. Smith of the British Museum I have been able to examine one of the cotypes of this species. Both the description and the figure given by Sowerby are quite erroneous and very misleading. It has no resemblance whatever to *antrosus,* but is undoubtedly a young shell of one of the many southern mutations of *trivolvis.*

PLANORBIS JENKSII Carpenter.

Planorbis jenksii Carpenter, Central Falls (R. I.) Visitor, Mar. 2, 1871; Con. Ex., II, 1887, p. 2.
Type locality: Pawtucket, R. I.

PLANORBIS LENTUS Say.

Fischer and Crosse (38, p. 65) restrict this species to the New Orleans form described by Say and do not consider that the figures given by Gould, Haldeman, Dunker and others represent the species. Dall (32, p. 86) refers it to *glabratus*.

PLANORBIS LIEBMANNI Dunker.

Is referred to *orbiculus* by Fischer and Crosse (38, p. 71), but is stated by Pilsbry (91, p. 322) to be distinct. It is the type of section *Tropicorbis* Brown and Pilsbry.

PLANORBIS MAGNIFICUS Pilsbry.

Planorbis magnificus Pilsbry, Naut., 1903, XVII, p. 75; Bartsch, Pr. U. S. Nat. Mus., XXXIII, 1908, p. 697, pl. 57, figs. 7-9.
Type locality: Cape Fear River, Wilmington, N. C.

PANORBIS MULTIVOLVIS Case.

Is a valid species and has been rediscovered at Howe Lake, Marquette Co., Mich. See Walker, 149, p. 61. Earlier citations of this species from Michigan, except the original one, and Newfoundland refer to *P. campanulatus rudentis*.

PLANORBIS NATHORSTI Westerlund.

Planorbis nathorsti Westerlund, Vega Exp., IV, 1887, p. 168.
Type locality: Aulatsivik, West Greenland.

PLANORBIS OCCIDENTALIS Cooper.

Planorbis occidentalis Cooper, Pr. Cal. Acad. Sci., IV, 1870, p. 99.
Type locality: Not given. Range: Washington Terr. to San José, Cal.
See *trivolvis*. Is the mature form of *tumens* according to Cooper (26, p. 89).

PLANORBIS OPERCULARIS Gould.

Planorbis lenticularis Sowerby, Con. Icon., Planorbis, 1876, Sp. 110, pl. 13, fig. 110.
Includes *planulatus* Cooper, *centervillensis* Tryon and *multilineatus* Van. (*oregonensis* Van.) as varieties according to Dall (32, p. 92), with *callioglyptus* Van. as a synonym of *planulatus*.

PLANORBIS OPERCULARIS MULTILINEATUS Vanatta.

Planorbis opercularis oregonensis Vanatta, Naut., IX, 1895, p. 54; *non* Tryon, 1865.
Planorbis opercularis multilineatus Vanatta, Naut., XIII, 1899, p. 48.
Type locality: Salem and Portland, Oregon.

PLANORBIS ORBICULUS Morelet.

Planorbis orbiculus Morelet, Test. Noviss., 1849, I, p. 17.

Includes *haldemani* Dunker (1850) *non haldemani* C. B. Adams (1849). Fischer and Crosse also include *liebmanni,* but Pilsbry (l. c.) considers it to be distinct.

PLANORBIS OREGONENSIS Tryon.

Planorbis oregonensis Tryon, Am. J. of Con., I, 1865, p. 231, pl. 22, fig. 17.
Type locality: Pueblo Valley, Oregon. See *trivolvis.*

PLANORBIS PARVUS Say.

Includes *billingsii* Lea according to Vanatta (136, p. 54) and Dall (32, p. 95) and *circumstriatus* Tryon according to Vanatta (l. c.).

PLANORBIS PARVUS WALKERI Vanatta.

Planorbis parvus walkeri Vanatta, Naut., XVI, 1902, p. 58.
Type locality: Hartland, Vt. Also Michigan.

PLANORBIS PERFORATUS "Gould?" Sowerby.

Planorbis perforatus Sowerby, Con. Icon., Planorbis, 1876, Sp. 105, pl. 13, fig. 105.
Type locality: United States.

Gould never described a *Planorbis* under this name. Clessin (20, p. 227) suggests that the species is perhaps from East Asia.

PLANORBIS PLANULATUS Cooper.

Is doubtfully referred to *P. opercularis* Gld. as a variety by Cooper (25, p. 100).

PLANORBIS PLEXATA Ingersoll.

Planorbis plexata Ingersoll, U. S. Geol. & Geog. Surv. Terr., 1874, p. 402, text-fig.
Type locality: St. Mary's Lake, Antelope Co., Col.

Is a var. of *trivolvis* according to Stearns (121, p. 105) and Cooper (26, p. 85).

PLANORBIS RUBELLUS Sterki.

Planorbis harni Pilsbry, Naut., IV, 1891, p. 137, *sine desc.*
Planorbis exacutus rubellus Sterki, L. and F. W. Moll., New Phila., 1894, p. 7.
Planorbis rubellus, Pilsbry, Naut., XIII, 1899, p. 51.
Type locality: Stone Creek Valley, Odbert's Station, O.

PLANORBIS SAMPSONI Ancey.

Planorbis sampsoni Ancey in Sampson, Bull. Sedalia N. H. Soc., No. 1, 1885, p. 10, text-fig.

Type locality: Flat Creek, Sedalia, Mo.

PLANORBIS SCALARIS (Jay).

Paludina scalaris Jay, Cat., 3rd ed., 1839, p. 112, pl. 1, figs. 8-9.

Physa scalaris Haldeman, Mon., 1842, p. 34, pl. IV, fig. 9; W. G. Binney, L. and F. W. Shells, Pt. II, 1865, p. 96, fig. 164.

Ameria scalaris Tryon, Mon., 1870, p. 168; Dall, Ann. N. Y. Lyc. N. H., IX, 1870, p. 356; Naut., III, 1889, p. 8.

Planorbis scalaris Pilsbry, Con. Ex., II, 1888, p. 113.

Physa (Thomsonia) carinifera Ancey, Le Nat., 1886, p. 358.

Type locality: Everglades of Florida.

Pilsbry (86, p. 287) states that this species is a *Planorbis*.

PLANORBIS SINUOSUS Bonnet.

Planorbis sinuosus Bonnet, Rev. & Mag. Zool., 1864, p. 280, pl. XXII, fig. 3.

Type locality: New Mexico.

Is referred to *glabratus* Say by Tryon (129, p. 183). Fischer and Crosse (38, p. 67) question this approximation, but as their opinion is based on Binney's figure (11, fig. 179), which does not represent Say's species, it is not of much value. However as *glabratus* is not known to occur outside of Florida, Tryon's suggestion is wrong anyway. Dr. Pilsbry informs me that it is *P. tumidus* Pfr.

PLANORBIS SUBCRENATUS DISJECTUS Cooper.

Planorbis subcrenatus disjectus Cooper, Pr. Cal. Acad. Sci., (2) III, 1890, p. 84, pl. 1, fig. 30.

Type locality: Tuolumne Meadows, Cal.

PLANORBIS TENUIS Phil.

Listed from the drift of the Santa Cruz River, Tucson, Ariz., by Pilsbry and Ferriss (109, p. 400).

PLANORBIS TRASKII Lea.

Planorbis traskii Lea, Jour. A. N. S. P., VI, 1866, p. 157, pl. XXIII, fig. 70; Obs., XI, 1866, p. 113, pl. XXIII, fig. 70.

Type locality: Kern Lake, Cal.

Dall (32, p. 88) considers this specifically distinct from *P. ammon*.

PLANORBIS TRIVOLVIS Say.

Includes *subcrenatus* Cpr., with *oregonensis* Tryon, *occidentalis* Cooper, and *tumens* Cooper, *non* Cpr., as synonyms and probably *hornii* Tryon according to Dall (32, p. 89). Pilsbry also (95, p. 65) lists *hornii* as a variety.

PLANORBIS TRIVOLVUS BINNEYI Tryon.

Planorbis corpulentus Gould, U. S. Expl. Exp., 1852, p. 114, fig. 130; Haldeman, Mon., 1844, p. 19, pl. III, figs. 7-9; W. G. Binney, L. & F. W. Shells, pt. II, 1865, p. 114, figs. 191-2; Sowerby, Con. Icon., 1877, Sp. 4, pl. I, fig. 4; pl. X, fig. 4b.
Planorbis binneyi Tryon, Am. J. of Con., III, 1867, p. 197.
Type locality: West Coast.

PLANORBIS UMBILICATELLUS Cockerell.

Planorbis umbilicatus Taylor, J. of Con., IV, 1885, p. 351, text-fig. *non* Müller (1774).
Planorbis umbilicatellus Cockerell, Con. Ex., 1885, II, p. 68.
Type locality: Brandon and Birtle, Manitoba. Ranges from New York to South Dakota. See also Vanatta (137, p. 117).

PLANORBIS VERMICULARIS Gould.

Is referred to *parvus* by Vanatta (136, p. 55), but is considered distinct by Dall (32, p. 95).

Genus SEGMENTINA Fleming, 1817.

Subgenus PLANORBULA Haldeman, 1842.

SEGMENTINA ARMIGERA (Say).

Dr. Pilsbry informs me that he has seen the type of *Planorbis lautus* H. Ads. and that it is a young specimen of this species.

SEGMENTINA ARMIGERA CAMPESTRIS Dawson.

Segmentina armigera campestris Dawson, Rep. Brit. N. A. Boundary Com., 1875, p. 349.
Type locality: Red River Valley, Canada.

SEGMENTINA CHRISTYI Dall.

Segmentina christyi Dall, Rep. Harriman Exp. XIII, 1905, p. 99, pl. 11, figs. 10-11.
Type locality: High Bluff, Manitoba; Fort Smith, Mackenzie River. Reported from South Dakota by Walker (151, p. 11).

SEGMENTINA CRASSILABRIS Walker.

Segmentina crassilabris Walker, Naut., XX, 1907, p. 122, pl. 7, figs. 4-6.
Type locality: Hamtramck, Wayne Co., Mich.

Segmentina declivis (Tate).

Planorbis declivis Tate, Am. J. of Con., V, 1869, p. 159.
Type locality: San Augustin, Acoyapa, Nicaragua.

Cited by Dall (32, p. 98) from Umpqua River, Oregon.

Hannibal (53, p. 158) states that it has not been found by any of the local collectors in that region and questions the authenticity of the locality of Dall's specimens.

Segmentina obstructa (Morelet).

Planorbis obstructus Morelet, Test. Noviss. I, 1849, p. 17.
Planorbis berendti Tryon, Am. J. of Con., II, 1866, p. 10, pl. 2, figs. 14-16.
Type locality: Carmen Island, Yucatan.

"Occurs abundantly in Texas as far north as Austin." (Pilsbry 91, p. 322. See also Pilsbry and Ferris, 106, p. 166.) In the absence of a figure of this species in any American publication, I have quoted that of *berendti* Tryon from Mexico, which is considered a synonym by Fischer and Crosse (38, p. 78) and von Martens (73, p. 398).

Segmentina wheatleyi (Lea).

Planorbis wheatleyi Lea, Jour. A. N. S. P. VI, 1866, p. 158, pl. 23, fig. 71; Obs. XI, 1866, p. 113, pl. 23, fig. 71.
Segmentina wheatleyi Walker, Naut. XX, 1907, p. 123, pl. VII, figs. 7-9.

Dall (32, p. 97) has proposed a new section, *Haldemanina,* for this species, based on the "complex, dentiform and ridgelike" lamellæ, but these differ from those of the other species (*armigera* and *crassilabris*) only in degree. See Pilsbry and Ferriss (106, p. 166) and Walker (l. c.).

Subfamily POMPHOLIGINÆ Dall, 1866.

Genus POMPHOLYX Lea, 1856.

Pompholyx leana H. and A. Adams.

Pompholyx leana H. and A. Adams, Pr. Zool. Soc. London, 1863, p. 434.
Type locality: West Columbia.

Pompholyx solida Dall.

Pompholyx var. *solida* Dall, Ann. N. Y. Lyc. Nat. Hist., IX, 1870, p. 335, pl. II, fig. 7a.
Type locality: West Columbia.

Dall states that his species is clearly not *effusa* Lea, but that in the absence of typical specimens of *P. leana* H. and A. Adams described from West Columbia, it still remains doubtful whether it belongs to the latter species.

Genus CARINIFEX W. G. Binney, 1863.

Megastropha Lea, 1866

CARINIFEX NEWBERRYI MINOR Cooper.

Carnifex newberryi var. ? *minor* Cooper, Pr. Cal. Acad. Sci., IV, 1870, p. 98.
Type locality not stated.

CARINIFEX PONSONBYI E. A. Smith.

Carinifex ponsonbyi E. A. Smith, P. Z. S. Lond., 1875, p. 536, text-fig.
Planorbis ponsonbyi Sowerby, Con. Icon., Planorbis 1876, Sp. 80, pl. X, figs. 80a-b.
Type locality: California.

Call (16, p. 149) states that the figure in the P. Z. S. is interchanged with that of *Diala leithii* described at the same time.

Family PHYSIDÆ.

Genus PHYSA Draparnaud.

Dall (32, p. 100) has proposed the following arrangement:

Section PHYSA S. S.

Type *P. fontinalis* L.

Section COSTATELLA Dall.

Type *P. costata* Newcomb.

For an excellent revision of the Eastern American species, see Crandall, No. 27.

Von Martens (73, p. 368) has proposed the subgenus *Alampetis* for the North American and Mexican species with a dull, not glossy, surface and (often) thickened lip. He gives no type, but mentions *P. ancillaria* as an example.

PHYSA ALBOFILATA Ancey.

Physa albofilata Ancey, in Sampson, Rep. Geol. Surv. Ark., II, 1891, p. 194.
Type locality: West Leatherwood Creek, Eureka Springs, Carroll Co., Ark.
See *gyrina*.

PHYSA ALTONENSIS Lea.

Physa altonensis Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 164, pl. 24, fig. 82; Obs., XI, 1866, p. 120, pl. 24, fig. 82.
Type locality: Alton, Ills.

Is *elliptica* according to Tryon (132, p. 163) and an abnormal *gyrina* according to Crandall (27, p. 71).

PHYSA AMPULLACEA Gould.

Includes *P. lordi* Bd., *propinqua* Try. and *coniformis* Try. as varieties according to Cooper (25, p. 98).

According to Henderson and Daniels (56, p. 52) it is possible that Lea's *P. nuttallii* may be this species. If so it would have priority.

PHYSA AMPULLACEA COLUMBIANA Hemphill.

Physa ampullacea columbiana Hemphill, Naut., IV, 1890, p. 27.
Type locality: Columbia River, Astoria, Oregon.

PHYSA AMYGDALUS Sowerby.

Physa amygdalus Sowerby, Con. Icon., Physa, 1873, Sp. 65, pl. 8, fig. 65.
Type locality: Texas.

PHYSA ANATINA Lea.

Physa anatina Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 171, pl. 24, fig. 94; Obs., XI, 1866, p. 127, pl. 24, fig. 94.
Type locality: Northern tributary of the Arkansas River, Kans.

PHYSA ANCILLARIA Say.

According to von Martens (73, p. 374) *Physa subarata* Mke. belongs to this species and not to *P. heterostropha* Say as supposed by Binney and is represented by fig. 1, pl. III of Haldeman's Monograph.

PHYSA ANCILLARIA CRASSA Walker.

Physa ancillaria crassa Walker, Naut., XIV, 1901, p. 98.
Type locality: Higgins Lake, Roscommon Co., Mich.
Types No. 1471 Coll. Walker.

PHYSA ANCILLARIA MAGNALACUSTRIS Walker.

Physa ancillaria magnalacustris Walker, Naut., XIV, 1901, p. 97.
Type locality: Frankfort, Benzie Co., Mich.
Types No. 9214 Coll. Walker.

PHYSA APLECTOIDES Sterki.

Physa aplectoides Sterki, Pr. O. St. Acad. Sci., IV, 1907, p. 381.
Type locality: Portage and Tuscawaras Co's., O. Also Isle Royale and Schoolcraft County, Michigan.

PHYSA AUREA Lea.

Is a synonym of *elliptica* and not of *heterostropha* according to Tryon (132, p. 163) and Crandall (27, p. 55).

PHYSA BILLINGSII Heron.

Physa billingsii Heron, Tr. Ott. F. Nat. Club, I, 1880, p. 62, pl. 2, fig. 5.
Type locality: Billings' Bridge, Ottawa, Ont.

Is a var. of *integra* according to Crandall (27, p. 15).

PHYSA BINNEYANA Ancey.

Physa diaphana Tryon, Am. J. of Con. I, 1865, p. 224, pl. 23, fig. 11, *non* Krauss (1848).
Physa binneyana Ancey, Le Nat., 1886, p. 358.
Type locality: Oakland, Cal.

PHYSA BLANDI Lea.

Physa blandi Lea, Pr. A. N. S. P., 1864, p. 116; Jour. A. N. S. P., VI, 1866, p. 168, pl. 24, fig. 88; Obs., XI, 1866, p. 124, pl. 24, fig. 88.
Type locality: California.

Includes *distinguenda* Try. and "?" is the same as *grosvernori* Lea and *nuttallii* Lea according to Cooper (25, p. 97). Both of the latter names have priority.

PHYSA BREVISPIRA Lea.

Physa brevispira Lea, Pr. A. N. S. P., 1864, p. 116; Jour. A. N. S. P., VI, 1866, p. 173, pl. 24, fig. 98; Obs., XI, 1866, p. 129, pl. 24, fig. 98.
Type locality: Ottawa River, Ont.

PHYSA CARLTONII Lea.

Physa carltonii Lea, Pr. A. N. S. P., 1869, p. 125; Jour. A. N. S. P., VIII, 1874, p. 63, pl. 21, fig. 19; Obs., XIII, 1874, p. 67, pl. 21, fig. 19.
Type locality: Mount Diablo, Cal.

PHYSA CONIFORMIS Tryon.

Physa coniformis Tryon, Am. J. of Con., II, 1866, p. 6, pl. II, fig. 5.
Type locality: Humboldt River, Oregon.

PHYSA COOPERI Tryon.

Physa cooperi Tryon, Am. J. of Con., I, 1865, p. 224, pl. 23, fig. 9.
Type locality: Crane Lake Valley, Cal.

Is a variety of *P. triticea* Lea according to Cooper (25, p. 97).

PHYSA CRANDALLI Baker.

Physa rhomboidea Crandall, Naut., XV, 1901, p. 44, pl. II, figs. 6-7, *non* Meek and Hayden (1856).
Physa crandalli Baker, Tr. Acad. St. Louis, XVI, 1906, p. 8.
Type locality: Cedar and Muddy Creeks, Sedalia, Mo. Also Dardenelles and Sulphur Springs, Ark., and Las Vegas, N. M.
Types No. 40775 Coll. Walker.
According to Springer (120, p. 513) is a synonym of *P. humerosa.*

PHYSA CROCATA Lea.

Physa crocata Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 169, pl. 24, fig. 90; Obs., XI, 1866, p. 125, pl. 24, fig. 90.
Type locality: Lafayette, Walker Co., Ga.
Is closely allied to *microstoma* Hald. according to Crandall (27, p. 70).

PHYSA CUPREONITENS Cockerell.

Physa cupreonitens Cockerell, J. of Con., VI, 1889, p. 63.
Type locality: Hot Spring, Wellsville, Colo.
Though described as a distinct species, in the text it is called a subspecies of *heterostropha.*

PHYSA CUBENSIS Pfeiffer.

Physa cubensis Pfeiffer, Wiegm. Archiv., I, 1839, p. 354.
Physa heterostropha peninsulæ Pilsbry, Naut., XIII, 1899, p. 48; ibid, XIII, 1899, p. 70.
Type locality: Cuba. Also Miami and elsewhere in Florida. See Rhoads (113, p. 48).

PHYSA DEFORMIS Currier.

Physa deformis Currier, Am. J. of Con., III, 1867, p. 112, pl. 6, fig. 1.
Type locality: Grand Rapids, Mich.
Is *elliptica* Lea according to Crandall (27, p. 54).

PHYSA DISTINGUENDA Tryon.

Physa distinguenda Tryon, Am. J. of Con., I, 1865, p. 225, pl. 23, fig. 6.
Type locality: Marysville and Stockton, Cal.

PHYSA DORBIGNYANA Lea.

Physa striata Lea, Pr. A. N. S. P. 1864, p. 115, *non* d'Orbigny (1853), *nec* Menke (1830).
Physa dorbignyana Lea, Jour. A. N. S. P., VI, 1866, p. 166, pl. 24, fig. 85; Obs., XI, 1866, p. 123, pl. 24, fig. 85.
Type locality: Monterey, Cal.
Is a synonym of *P. virgata* Gld. according to Pilsbry and Ferriss (108, p. 198).

PHYSA ELLIPTICA Lea.

Is a valid species according to Crandall (27, p. 54) and includes *troostiana* Lea and *minor* Crandall as varieties and *aurea, febigeri* and *nicklinii* Lea and *deformis* Currier as synonyms. Baker's figures (4, pl. 34, fig. 5), copied by Blatchley and Daniels (14, pl. I, fig. 118) do not represent the true *elliptica*.

PHYSA ELLIPTICA MINOR Crandall.

Physa elliptica minor Crandall, Naut., XV, 1901, p. 55.
Type locality: Grand Rapids, Mich.
Types No. 14469 Coll. Walker.

PHYSA FEBIGERI Lea.

Physa febigeri Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 174, pl. 24, fig. 99; Obs., XI, 1866, p. 130, pl. 24, fig. 99.
Type locality: Logan Co., O.
Is *elliptica* according to Tryon (132, p. 163) and Crandall (27, p. 55).

PHYSA FORSHEYI Lea.

Physa forsheyi Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 172, pl. 24, fig. 95; Obs., XI, 1866, p. 128, pl. 24, fig. 95.
Type locality: Rutersville, Texas.
Includes *whitei* Lea according to Crandall (27, p. 67).

PHYSA FRAGILIS Mighels.

Is a pathologic form of *ancillaria* according to Morse (75, p. 43).

PHYSA GROSVERNORI Lea.

Physa grosvernori Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 175, pl. 24, fig. 100; Obs., XI, 1866, p. 131, pl. 24, fig. 100.
According to Cooper (25, p. 97) includes *P. traskii* Lea, *occidentalis* Try., *dorbignyana* Lea and *sparsestriata* Try. as varieties.
Type locality: Santa Rita Valley.
Is a var. of *forsheyi* according to Crandall (27, p. 69).

PHYSA GYRINA Say.

Includes *cylindrica* Newc., *altonensis, hawnii* and *smithsoniana* Lea as synonyms and *albofilata* Ancey, *hildrethiana* Lea and *oleacea* Tryon as varieties according to Crandall (27, p. 45).

PHYSA HALEI Lea.

Physa halei Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 165, pl. 24, fig. 83; Obs., XI, 1866, p. 121, pl. 24, fig. 83.
Type locality: Alexandria, La.

PHYSA HAWNII Lea.

Physa hawnii Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 165, pl. 24, fig. 84; Obs., XI, 1866, p. 121, pl. 24, fig. 84.
Type locality: Verdigris River, Kans.
Is *gyrina* according to Tryon (132, p. 162) and Crandall (27, p. 54).

PHYSA HETEROSTROPHA Say.

Includes *lata* and *primeana* Tryon according to Crandall (27, p. 29).

PHYSA HETEROSTROPHA ALBA Crandall.

Physa heterostropha alba Crandall, Naut., XV, 1901, p. 29.
Type locality: Cedar Lake, Capachet, N. Y.
Types No. 40747 Coll. Walker.

PHYSA HUMEROSA Gould.

Includes *rhomboidea* Crandall (*crandalli* Baker), according to Springer (120, p. 513).

PHYSA INTEGRA Haldeman.

Includes *billingsii* as a var. according to Crandall (27, p. 56).

PHYSA LATA Tryon.

Physa lata Tryon, Am. J. of Con., I, 1865, p. 227, pl. 23, fig. 7.
Type locality: Juniata River, Hallidaysburg, Pa.
See *heterostropha*.

PHYSA LORDI Baird.

Physa parkeri Currier, Kent Sci. Inst., Misc. Pub., 1868, p. 7 (no desc.); DeCamp, Kent Sci. Inst., Misc. Pub., No. 5, 1881, p. 15, pl. 1, fig. 3.
Type locality (*parkeri*): Houghton Lake, Mich.
Types (*parkeri*) No. 11997 Coll. Walker.
Henderson and Daniels (56, p. 75) suggest that the Michigan and Canadian forms differ markedly from the typical western form.

PHYSA MALLEATA Tryon.

Physa malleata Tryon, Am. J. of Con., I, 1865, p. 225, pl. 23, fig. 14.
Type locality: Hell Gate River, Oregon.

PHYSA MARGARITA Lesson.

Physa margarita Lesson, Rev. Zool., 1840, p. 356.
Type locality: Newfoundland.

PHYSA MEXICANA CONOIDEA Fischer and Crosse.

Physa mexicana conoidea Fischer and Crosse, Moll. Mex., II, 1886, p. 101, pl. 39, figs. 8-8a.
Type locality: Mehedin, Mexico.
Also McLennan Co., Texas, see Strecker, 126, p. 64.

PHYSA NIAGARENSIS Lea.

Physa niagarensis Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 168, pl. 24, fig. 97; Obs., XI, 1866, p. 124, pl. 24, fig. 97.
Type locality: Niagara River, N. Y.
Is referred to *integra* by Tryon, (132, p. 167), but Crandall (27, p. 55) considers it distinct.

PHYSA NICKLINII Lea.

Physa nicklinii Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 175, pl. 24, fig. 101; Obs., XI, 1866, p. 131, pl. 24, fig. 101.
Type locality: Callaghan's, Alleghany Co., Va.
Is *elliptica* according to Tryon (132, p. 163) and Crandall (27, p. 55).

PHYSA NUTTALLII Lea.

Physa nuttallii Lea, Pr. A. N. S. P., 1864, p. 116; Jour. A. N. S. P., VI, 1866, p. 171, pl. 24, fig. 93; Obs., XI, 1866, p. 127, pl. 24, fig. 93.
Type locality: Lewis River, Oregon.
See *ampullacea*.

PHYSA OCCIDENTALIS Tryon.

Physa occidentalis Tryon, Am. J. of Con., I, 1865, p. 226, pl. 2, fig. 8.
Type locality: San Francisco and numerous other localities in California and Oregon.

PHYSA OLEACEA Tryon.

Physa oleacea Tryon, Am. J. of Con., II, 1866, p. 6, pl. II, fig. 6.
Type locality: Bridgeport, Ala., and Lake Superior.
Is *elliptica* according to Tryon (132, p. 163). Crandall states (27, p. 45) that Tryon himself admitted this obvious error and considers it to be a var. of *gyrina*. Baker (5, p. 492) considers it to be simply an immature stage of typical *gyrina*.

PHYSA OSCULANS Haldeman.

Includes *mexicana* Phil. according to Fischer and Crosse (38, p. 100), Pilsbry (91, p. 323) and von Martens (73, p. 370). "*Physa osculans* is readily distinguishable from the eastern forms, *P. heterostropha, integra* and *gyrina;* but several described Californian Physas present no differences from the Mexican species and must be considered synonyms." (Pilsbry, l. c.)

PHYSA PARVA Lea.

Physa parva Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 177, pl. 24, fig. 104; Obs., XI, 1866, p. 133, pl. 24, fig. 104.
Type locality: Verdigris River and Roca Creek, Kans.

Is doubtfully referred to *P. malleata* Try. as a variety by Cooper (25, p. 97).

Probably a young *grosvernori,* Tryon (128, p. 169); is *gyrina,* Tryon (132, p. 162); probably a young *anatina,* Crandall (27, p. 71).

PHYSA POLITISSIMA Tryon.

Physa politissima Tryon, Am. J. of Con., I, 1865, p. 226, pl. 23, fig. 13.
Type locality: Sacramento, Cal.

Is a variety of *P. binneyana* Ancey (*P. diaphana* Try.) according to Cooper (25, p. 97).

Is probably a synonym of *triticea,* and both are "dwarfed and arrested aspect (s)" of *gyrina* according to Stearns (122, p. 51).

PHYSA POMILIA Conrad.

Physa pomilia Conrad, Am. J. of Sci., XXV, 1834, p. 343; Am. J. of Con., II, 1866, p. 278, pl. 15, figs. 1-3.
Type locality: Randon's Creek, Claiborne, Ala.

Includes *showalteri* Lea according to Tryon (132, p. 162) and Crandall (27, p. 90).

PHYSA PRIMEANA Tryon.

Physa primeana Tryon, Am. J. of Con., I, 1865, p. 227, pl. 23, fig. 12.
Type locality: Long Island, N. Y.

Is *heterostropha* according to Crandall (27, p. 29).

PHYSA PROPINQUA Tryon.

Physa propinqua Tryon, Am. J. of Con., I, 1865, p. 223, pl. 23, fig. 5.
Type locality: Jordan Creek, Idaho.

PHYSA RIVALIS Sowerby.

Physa rivalis Sowerby, Con. Icon., Physa, 1873, Sp. 31, pl. 4, fig. 31.
Type locality: Columbia River.

This is not the *P. rivalis* of Maton and Rackett (1807) nor of Sowerby (1821-6). Clessin (20, p. 331) considers it a synonym of *hildrethiana* Lea.

PHYSA SAFFORDII Lea.

Physa saffordii Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 166, pl. 24, fig. 87; Obs., XI, 1866, p. 123, pl. 24, fig. 87.

Type locality: Lebanon, Wilson Co., Tenn.; Verdigris River, Kans., and Nashville, Tenn.

Is *gyrina* according to Tryon (132, p. 162).

PHYSA SHOWALTERI Lea.

Physa showalteri Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 170, pl. 24, fig. 92; Obs., XI, 1866, p. 126, pl. 24, fig. 92.

Type locality: Uniontown, Ala.

PHYSA SMITHSONIANA Lea.

Physa smithsoniana Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 169, pl. 24, fig. 97; Obs., XI, 1866, p. 125, pl. 24, fig. 91.

Type locality: Loup Fork of the Platte River.

Is *gyrina* according to Crandall (27, p. 54).

PHYSA SPARSESTRIATA Tryon.

Physa sparsestriata Tryon, Am. J. of Con., I, 1865, p. 224, pl. 23, fig. 10.

Type locality: San Joaquin Valley, Cal.

PHYSA SUBROTUNDA Sowerby.

Physa subrotunda Sowerby, Con. Icon., Physa, 1873, Sp. 87, pl. 10, fig. 87.

Type locality: North America.

PHYSA TENUISSIMA Lea.

Physa tenuissima Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 167, pl. 24, fig. 86; Obs., XI, 1866, p. 123, pl. 24, fig. 86.

Type locality: Alexandria, La.

Is referred to *Aplexa* by Tryon (132, p. 17). See Crandall (27, p. 71). His shell now in my collection is a dead, bleached specimen of *Aplexa hypnorum*.

PHYSA TRASKII Lea.

Physa traskii Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 163, pl. 24, fig. 80; Obs., XI, 1866, p. 119, pl. 24, fig. 80.

Type locality: Rio Los Angelos, Cal.

Is a synonym of *P. virgata* Gld. according to Pilsbry and Ferriss (108, p. 198).

PHYSA TRITICEA Lea.

Physa triticea Lea, Jour. A. N. S. P., VI, 1866, p. 177, pl. 24, fig. 103; Obs., XI, 1866, p. 132, pl. 24, fig. 103.
Type locality: Shasta Co., Cal.

Is a form of *gyrina* and probably includes *politissima* Tryon, according to Stearns (122, p. 51).

PHYSA TROOSTIANA Lea.

Is *elliptica* according to Tryon (132, p. 163) and Crandall (27, p. 55).

PHYSA VENUSTA Lea.

Physa venusta Lea, Pr. A. N. S. P., 1864, p. 116; Jour. A. N. S. P., VI, 1866, p. 168, pl. 24, fig. 89; Obs., XI, 1866, p. 124, pl. 24, fig. 89.
Type locality: Fort Vancouver, Oregon.

Very closely allied to, if not identical with, *P. virginea* Gld. according to Tryon (128, p. 170), who also remarks in 1870 (Mon., p. 138) that it groups with *gyrina* Say.

PHYSA VINOSA Gould.

Crandall (27, p. 42) considers this to be a vár. of *ancillaria,* but it seems to be sufficiently distinct.

PHYSA VIRGATA Gould.

Listed from Muscatine, Ia., by Nelson (76, p. 182). In all probability an erroneous identification. Is a variety of *P. humerosa* Gld. according to Cooper (25, p. 98).

Widely, if sparsely, distributed in Arizona and New Mexico according to Pilsbry and Ferriss (107, p. 144).

PHYSA VIRGATA ALBA Cockerell.

Physa virgata mut. *alba* Cockerell, Jour. Mal., IX, 1902, p. 138.
Type locality: Salt River, Tempe, Ariz.

The varietal name is preoccupied by Crandall, *P. heterostropa alba,* 1901.

PHYSA WALKERI Crandall.

Physa walkeri Crandall, Naut., XV, 1901, p. 57, pl. II, fig. 5.
Type locality: Petoskey, Mich.

Types No. 3483 Coll. Walker.

PHYSA WARRENIANA Lea.

Physa warreniana Lea, Pr. A. N. S. P., 1864, p. 115; Jour. A. N. S. P., VI, 1866, p. 163, pl. 24, fig. 81; Obs., XI, 1866, p. 120, pl. 24, fig. 81.
Type locality: Long Fork of the Platte River; Milwaukee, Wis.; Grand Rapids, Mich.

Is a var. of *sayii* according to Crandall (27, p. 44).

PHYSA WHITEI Lea.

Physa whitei Lea, Pr. A. N. S. P., 1864, p. 114; Jour. A. N. S. P., VI, 1866, p. 172, pl. 24, fig. 96; Obs., XI, 1866, p. 128, pl. 24, fig. 96.
Type locality: Walker Co., Ga.; Verdigris River, Kans.
Is *forsheyi* according to Crandall (27, p. 69).

PHYSA WOLFIANA Lea.

Physa wolfiana Lea, Pr. A. N. S. P., 1869, p. 125; Jour. A. N. S. P., VIII, 1874, p. 63, pl. 21, fig. 20; Obs., XIII, 1874, p. 67, pl. 21, fig. 20.
Type locality: Hot Springs, Colo.

Genus APLEXA Fleming, 1822.

APLEXA HORDACEA (Lea).

Physa hordacea Lea, Pr. A. N. S. P., 1864, p. 116; Jour. A. N. S. P., VI, 1866, p. 176, pl. 24, fig. 102; Obs., XI, 1866, p. 132, pl. 24, fig. 102.
Type locality: Vancouver Island, Oregon.

Referred to *Aplexa* by Tryon (132, p. 170), and doubtfully by Dall (32, p. 113), but its generic position still remains to be definitely settled by an examination of the animal. Dall (l. c.) states that the types came from Vancouver, Wash. and not from Vancouver Island, B. C.

Is a variety of *P. venusta* Lea according to Cooper (25, p. 97).

APLEXA HYPNORUM L.

Clessin (20, p. 287) distinguishes the American form (*P. elongata* Say) on the ground that the European form has a more slender shell and never a short spire as is the case with both the American varieties recognized by him, but the concensus of opinion is against him.

APLEXA HYPNORUM ARCTICA (Clessin).

Physa elongata arctica Clessin, Con. Cab., Limnæiden, 1886, p. 287, pl. 41, fig. 5.
Type locality: Hudson Bay.

APLEXA HYPNORUM GLABRA (DeKay).

Physa glabra DeKay, N. Y. Moll., 1843, p. 80, pl. 5, fig. 83.
Physa elongatina Lewis, Pr. B. S. N. H., V, 1855, pp. 122, 298.
Range: Conn., N. Y., and Michigan.

This form seems to be entitled to recognition as a well marked race.

APLEXA HYPNORUM TRYONI (Currier).

Bulinus tryoni Currier, Am. J. of Con., III, 1867, p. 112, pl. 6, fig. 2.
Type locality: Grand Rapids, Mich.

Family ANCYLIDÆ.

For a revision of the patelliform genera of this family, see Walker, No. 160.

Subfamily LANCINÆ Hannibal, 1914.

Genus LANX Clessin, 1880.

LANX ALTUS (Tryon).

Ancylus altus Tryon, Am. J. of Con., I, 1865, p. 230, pl. 22, fig. 15.
Type locality: Klamath River, Cal.

Is probably only a var. of *newberryi* according to Pilsbry (95, p. 65).

LANX CRASSUS (Haldeman).

Ancylus crassus Haldeman, Mon., 1844, p. 14, pl. 1, fig. 8.

LANX KOOTANIENSIS (Baird).

Ancylus kootaniensis Baird, Pr. Zool. Soc., Lond., 1863, p. 69; W. G. Binney, L. and F. W. Shells, II, 1865, p. 144, fig. 242; Tryon, Mon., 1870, p. 227, pl. 11, figs. 11-12.

Ancylus (Lævapex) kootaniensis Dall, Alaska, XIII, 1905, p. 110, fig. 82. Is doubtfully referred to *L. crassus* Hald. as a variety by Cooper (25, p. 100).

LANX NEWBERRYI (Lea).

Ancylus newberryi Lea, Jour. A. N. S. P., VI, 1866, p. 185, pl. 24, fig. 116; Obs., XI, 1866, p. 141, pl. 24, fig. 116.

LANX NUTTALLII (Haldeman).

Vellettia nuttallii Haldeman, Mon., 1841, pt. 3, p. 3 of cover.
Acroloxus nuttallii Binney, L. and F. W. Shells, II, 1865, p. 147.

LANX PATELLOIDES (Lea).

Ancylus patelloides Lea, Jour. A. N. S. P., VI, 1866, p. 185, pl. 24, fig. 117; Obs., XI, 1866, p. 141, pl. 24, fig. 117.

Is not a marine species as stated by Tryon (132, p. 230). See Pilsbry (93, p. 60).

Includes *altus* Try. and *subrotundus* Try. and doubtfully *newberryi* Lea as varieties according to Cooper (25, p. 100).

LANX PRÆCLARUS (Stimpson). (Mss.?)

Ancylus præclarus "Stimpson" Lea, Obs. XI, 1866, p. 141.
This apparently undescribed species is referred to and distinguished from *newberryi* by Lea.

LANX SUBROTUNDUS (Tryon).

Ancylus subrotundus Tryon, Am. J. of Con., I, 1863, p. 230, pl. 22, fig. 14.
Type locality: Umpqua River, Oregon.

Subgenus WALKEROLA Hannibal, 1912.

LANX (WALKEROLA) KLAMATHENSIS Hannibal.

Lanx (*Walkerola*) *klamathensis* Hannibal, Pr. Mal. Soc. Lond., X, 1912, p. 149, pl. VIII, fig. 25.
Type locality: Upper Klamath Lake, Ore.

Genus FISHEROLA Hannibal, 1912.

FISHEROLA LANCIDES Hannibal.

Fisherola lancides Hannibal, Pr. Mal. Soc. Lond., X, 1912, p. 152, pl. VIII, fig. 35.
Type locality: Snake River, Washington.

Genus ACROLOXUS Beck.

Does not occur in our fauna. Of the two species referred to it by Binney, one, *A. nuttallii,* is a *Lanx* and the other, *A. filosus,* is a *Rhodacmea.*

Subfamily FERRISSIINÆ Walker, 1917.

Genus FERRISSIA Walker, 1903.

FERRISSIA BOREALIS (Morse).

Ancylus borealis Walker, Naut., XVIII, 1904, p. 80, pl. 6, figs. 14-16.

FERRISSIA CAURINA ("W. Cooper," W. G. Binney).

Ancylus caurinus, J. G. Cooper, Pr. Cal. Acad. Sci., IV, 1870, p. 100.
Tryon (132, p. 229) refers this species to *fragilis,* but it is an error.
Is doubtfully referred to *Ferrissia fragilis* Try. as a variety by Cooper (25, p. 100), but later (26, p. 83) he considers it distinct. Dall (32, p. 110) also doubtfully refers it to *fragilis.*

FERRISSIA CAURINA SUBALPINA (J. G. Cooper).

Ancylus caurinus subalpinus J. G. Cooper, Pr. Cal. Acad. Sci., (2), III, 1890, p. 82, pl. 1, figs. 27-28.
Type locality: Yosemite Valley and Bloody Canyon, Cal. Also Oregon.

FERRISSIA FRAGILIS (Tryon).

As suggested by J. G. Cooper (26, p. 83), and Hannibal (53, p. 148), this is probably the non-septate form of *Gundlachia californica.*

FERRISSIA HALDEMANI (Bourguinat).

Ancylus haldemani Walker, Naut., XVIII, 1904, p. 78, pl. 6, figs. 9-13.

FERRISSIA HENDERSONI (Walker).

Ancylus hendersoni Walker, Naut., XXI, 1908, p. 138, pl. 9, figs. 8-10.
Type locality: Lake Waccamaw, N. C.

FERRISSIA NOVANGLIÆ (Walker).

Ancylus novangliæ Walker, Naut., XXI, 1898, p. 138, pl. 9, figs. 5-7.
Type locality: Cambridge, Mass.

FERRISSIA OVALIS (Morse).

Ancylus ovalis Walker, Naut., XVIII, 1904, p. 79.

FERRISSIA PARALLELA (Haldeman).

Ancylus parallelus Walker, Naut., XVIII, 1914, p. 77, pl. 5, figs. 1-9.

FERRISSIA PUMILA (Sterki).

Ancylus pumilus Sterki, 8th Ann. Rep. O. St. Acad. Sci, 1900, p. 36; separate, p. 7; Walker, Naut., XVIII, 1904, p. 82, pl. 6, figs. 20-22.
Type locality: Tuscawaras River, Tuscawaras Co., O.

It is possible that this will prove to be the non-septate form of *Gundlachia meekiana.*

FERRISSIA RIVULARIS (Say).

Ancylus rivularis Walker, Naut., XVIII, 1904, p. 25, pl. 1, figs. 1-10, 13-14.

FERRISSIA SHIMEKII (Pilsbry).

Ancylus obliquus Shimek, Bull. Lab. Nat. Hist., St. Univ. Ia., I, 1890, p. 214, pl. III, figs. 5a-c, *non* Broderip and Sowerby (1832), nor C. B. Ads. (1850), nor Krauss (1853).
Ancylus shimekii Pilsbry, Naut., IV, 1890, p. 48; Walker, Naut., XVIII, 1904, p. 81, pl. 6, figs. 17-19.
Type locality: Deadman's Run, Lincoln, Neb.

Pilsbry (l. c. and 54, p. 63) has suggested that this may be the non-septate form of a *Gundlachia,* perhaps *meekiana.* This was controverted by Walker (l. c.), but nevertheless may be correct.

FERRISSIA TARDA (Say).

Ancylus tardus Walker, Naut., XVIII, 1904, p. 27, pl. I, figs. 11-12, 16-23; pl. II, figs. 1-23.

FERRISSIA WALKERI (Pilsbry and Ferriss).

Ancylus walkeri Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 564, fig. 5.
Type locality: Rogers, Benton Co., Ark.

Subgenus LÆVAPEX Walker, 1903.

FERRISSIA DIAPHANA (Haldeman).

Ancylus diaphanus Walker, Naut., XVII, 1903, p. 17, pl. II, figs. 13-18.

FERRISSIA EXCENTRICA (Morelet).

Ancylus excentricus Morelet, Test. Noviss., II, 1851, p. 17; Pilsbry, Naut., III, 1889, p. 64, pl. I, fig. 4; Walker, Naut., XVII, 1903, p. 27, pl. I, figs. 19-21.
Type locality: Lago de Ita, Peten, Guatemala. Also Comal Creek, New Braunfels and Barton Creek, Travis Co., Texas.

FERRISSIA FUSCA (C. B. Adams).

Ancylus fuscus Walker, Naut., XVII, 1903, p. 15, pl. I, fig. 1-9.

FERRISSIA FUSCA EUGRAPTA (Pilsbry).

Ancylus eugraptus Pilsbry, Naut., IX, 1896, p. 139.
Ancylus fuscus eugraptus Walker, Naut., XVII, 1903, p. 17, pl. I, figs. 13-18.
Type locality: Illinois River, Havana, Ills.

FERRISSIA HEMISPHÆRICA (Walker).

Ancylus hemisphæricus Walker, Naut., XXI, 1908, p. 140, pl. 9, figs. 14-16.
Type locality: Georgia. Also Decatur, Ala.

FERRISSIA KIRKLANDI (Walker).

Ancylus kirklandi Walker, Naut., XVII, 1903, p. 29, pl. II, figs. 1-12.
Type locality: Grand Rapids, Mich.

FERRISSIA OBSCURA (Haldeman).

See Walker (Naut., XVII, 1903, p. 25, pl. I, figs. 16-18) for the Floridan form doubtfully referred to this. Rediscovered in the south fork of the Powell River at Big Stone Gap, Wise Co., Va., by Goodrich (48, p. 92), and quite different from the supposed Florida examples.

FERRISSIA PENINSULÆ (Pilsbry and Johnson).

Ancylus peninsulæ Pilsbry and Johnson, Naut., IX, p. 138; Walker, Naut., XVII, 1903, p. 28, pl. II, figs. 19-21.

Type locality: St. John's River, Fla.

SPECIES INCERTÆ SEDIS.

ANCYLUS CALCARIUS DeKay.

ANCYLUS OREGONENSIS Clessin.

Ancylus oregonensis Clessin, Con. Cab., Ancylinen, 1882, p. 66, pl. 8, fig. 1.

Type locality: Salem, Oregon.

Also listed from the Sacramento River, Reading, Shasta Co., by Pilsbry (93, p. 60).

Genus GUNDLACHIA Pfeiffer, 1849.

The validity of this genus has been a subject of considerable discussion. See Dall (31, p. 97) and Walker (148, p. 14, and 160, p. 3). Dall has also published a very interesting series of observations on the relations of *Ancylus* and *Gundlachia* (34, p. 175).

Subgenus GUNDLACHIA s. s.

GUNDLACHIA ANCYLIFORMIS Pfeiffer.

Gundlachia ancyliformis Pfeiffer, Zeitsch. für Mal., 1849, p. 98; Ibid, 1853, p. 180, pl. I, figs. 1-16.

Type locality: Lagune Injinio, San Vincente, Cuba.

Listed by Simpson (117, p. 96), from Palma Sola, Fla.

GUNDLACHIA HJALMARSONI Pfeiffer.

Gundlachia hjalmarsoni Pfeiffer, Mal. Blätt., V, 1858, p. 197.

Type locality: Santa Rosa, Honduras.

Has been recorded and figured by Clapp (18, p. 77), from the drift of the Rio Grande, at Brownsville, Texas.

Subgenus KINCAIDELLA Hannibal, 1912.

This group includes: *G. meekiana* Stimp., *californica* Row., and *stimpsoniana* S. Smith.

GUNDLACHIA STIMPSONIANA S. Smith.

Gundlachia stimpsoniana S. Smith, Ann. N. Y. Lyc. Nat. Hist., IX, 1870, p. 399, fig. 6; Walker, Naut., XXI, 1907, p. 15, pl. IV.

Type locality: Greenport, Long Island, N. Y. Also on Shelter Island, N. Y.

Subfamily RHODACMEINÆ Walker, 1917.

Genus RHODACMEA Walker, 1917.

Subgenus RHODACMEA s. s.

RHODACMEA FILOSA (Conrad).

Ancylus filosus Conrad, New F. W. Shells, 1834, p. 57; Haldeman, Mon., 1844, p. 10, pl. I, fig. 9; Binney, L. and F. W. Shells, II, 1865, p. 147, fig. 248; Walker, Naut., XVIII, p. 75, pl. 6, figs. 7-8.

Acroloxus filosus Tryon, Mon., 1870, p. 232.

Type locality: Black Warrior River, south of Blount Springs.

RHODACMEA CAHAWBENSIS Walker.

Ancylus filosus Walker, Naut., XVIII, 1904, p. 76, pl. VI, figs. 1-6.

Rhodacmea cahawbensis Walker, Naut., XXXI, 1917, p. 7, pl. I, figs. 4-6.

Type locality: Cahawba River, Gurnee, Shelby Co., Ala.

RHODACMEA ELATIOR (Anthony).

Ancylus elatior Anthony, Ann. N. Y. Lyc. Nat. Hist., VI, 1855, p. 158, pl. V, fig. 20; Binney, L. and F. W. Shells, II, 1865, p. 140, fig. 234; Walker, Naut., XVIII, 1904, p. 78, pl. V, figs. 10-12.

Type locality: Green River, Ky.

RHODACMEA HINKLEYI Walker.

Ancylus rhodaceus "Walker," Hinkley, Naut., XX, 1906, p. 40, not described.

Ancylus hinkleyi Walker, Naut., XXI, 1908, p. 139, pl. IX, figs. 11-13.

Type locality: Ohio River, Golconda, Ills.

Section RHODOCEPHALA Walker, 1917.

RHODACMEA RHODACME Walker.

Rhodacmea rhodacme Walker, Naut., XXXI, 1917, p. 8, pl. I, figs. 1, 2 and 8.

Type locality: Coosa River, Williamsville, Shelby Co., Ala.

RHODACMEA GWATKINIANA Walker.

Rhodacmea gwatkiniana Walker, Naut., XXXI, 1917, p. 9, pl. I, figs. 3, 7 and 9.

Type locality: Coosa River, Butting Ram Shoals, Coosa Co., Ala.

Subfamily NEOPLANORBINÆ Hannibal, 1912.

Genus NEOPLANORBIS Pilsbry, 1906.

NEOPLANORBIS CARINATUS Walker.

Neoplanorbis carinatus Walker, Naut., XXI, 1908, p. 127, pl. 9, figs. 17-18.
Type locality: Duncan's Riffle, Coosa River, Coosa Co., Ala.

NEOPLANORBIS SMITHII Walker.

Neoplanorbis smithii Walker, Naut., XXI, 1908, p. 126, pl. 9, figs. 1-2.
Type locality: Higgin's Ferry, Coosa River, Chilton Co., Ala.

NEOPLANORBIS TANTILLUS Pilsbry.

Planorbis tantillus "Pilsbry" Hinkley, Naut., XVIII, 1904, p. 54. Nude name.
Neoplanorbis tantillus Pilsbry, Naut., XX, 1906, p. 51, pl. 3, figs. 3-5.
Type locality: Wetumpka, Ala.

NEOPLANORBIS UMBILICATUS Walker.

Neoplanorbis umbilicatus Walker, Naut., XXI, 1908, p. 126, pl. 9, figs. 3-4.
Type locality: The Bar, Coosa River, Chilton Co., Ala.

Genus AMPHIGYRA Pilsbry.

Amphigyra Pilsbry, Naut., XX, 1906, p. 49.
Type: *Amphigyra alabamensis* Pils.

AMPHIGYRA ALABAMENSIS Pilsbry.

Amphigyra alabamensis Pilsbry, Naut., XX, 1906, p. 50, pl. III, figs. 1-2.
Type locality: Wetumpka, Ala.

Subclass STREPTONEURA.

Order PECTINIBRANCHIA.

Suborder TÆNIOGLOSSA.

Superfamily PLATYPODA.

Family AMPULLARIDÆ.

Genus AMPULLARIA Lamarck, 1799.

AMPULLARIA BOREALIS Valenciennes.

W. G. Binney (12, p. 430), has definitely ascertained that this species was based on the well known *Natica heros* Say.

AMPULLARIA CALIGINOSA Rve.

Ampullaria caliginosa Reeve, Con. Icon., Ampullaria, 1856, pl. XXV, fig 118.

Type locality: Unknown. Not listed by Sowerby in his recent catalogue (119, pp. 345-362).

Listed from several localities in Florida by Dall and Simpson.

AMPULLARIA MIAMIENSIS Pilsbry.

Ampullaria miamiensis Pilsbry, Pr. A. N. S. P., 1899, p. 365.
Type locality: Miami, Dade Co., Fla.

AMPULLARIA PALUDOSA Say.

This name must be used for Say's species as his first name *depressa* was preoccupied by Lamarck.

AMPULLARIA PINEI Dall.

Ampullaria pinei Dall, Naut., XII, 1898, p. 75.
Type locality: Homosassa River, Fla.

AMPULLARIA ROTUNDATA Say.

Sowerby has recently (119, p. 357) referred this species with doubt to *paludosa*, overlooking Say's statement that the operculum was calcareous and Binney's figure in his edition of Say, pl. 75. It is no doubt an Old World species as suggested by Binney. In a recent letter, Mr. Sowerby says that he has "not the slightest doubt that it is a small specimen of the Indian *A. globosa* Sw."

Family VIVIPARIDÆ.

Genus VIVIPARUS Montfort, 1810.

VIVIPARUS CONTECTUS (Millet).

This European species has become fully acclimatized at Washington, D. C., and at Philadelphia, Pa. (Bailey, 2, p. 60).

VIVIPARUS CONTECTOIDES W. G. Binney.

Tryon's contention (132, p. 17) that this species should be known as *V. lineata* Kuster *non* Val. (Con. Cab., Paludina, 1852, p. 10, pl. 2, figs. 6-9) is not well founded. *Lineata* is preoccupied and *linearis* (Ibid, p. 19) is "of course" a misprint for *lineata* as stated by Tryon (131, p. 197) and Binney (13, p. 295).

This species has been introduced and fully acclimated in Fairmont Park, Philadelphia, Pa. (Vanatta, 139, p. 84), and in the Public Garden in Boston, Mass. (Johnson, 62, p. 72).

VIVIPARUS CONTECTOIDES COMPACTUS Pilsbry.

Viviparus contectoides compactus Pilsbry, Naut., XXX, 1916, p. 42.
Type locality: Doherty, Ga.

VIVIPARUS CONTECTOIDES IMPOLITUS Pilsbry.

Viviparus contectoides impolitus Pilsbry. Naut., XXX, 1916, p. 41.
Type locality: Paint Rock River, Jackson Co., Ala.

VIVIPARUS GEORGIANUS ALTIOR Pilsbry.

Vivipara georgiana altior Pilsbry, Naut., V, 1892, p. 142.
Type locality: Hitchin's Creek, Fla.

VIVIPARUS GEORGIANUS FASCIATUS Tryon.

Vivipara georgiana fasciata Tryon, Mon., 1870, p. 17.
Type locality not specified.

VIVIPARUS GEORGIANUS LIMNOTHAUMUS Pilsbry.

Vivipara georgiana limnothauma Pilsbry, Naut., VIII, 1895, p. 116.
Type locality: Hitchin's Creek, Fla. Also Lake George, opposite Drayton's Island, Fla.

VIVIPARUS HALDEMANIANUS "Shuttleworth" Frauenfeld.

Vivipara haldemaniana "Shuttleworth" Frauenfeld, Verh. k. k. zool.-bot. Gesell. Wien, 1862, p. 1162.
Type locality: Black Creek, Fla.

Tryon (130, p. 374) says that this is "doubtless" *V. lineata* Val. (*contectoides* W. G. Binn.), but this is not likely as that species does not range so far south. It is more probable that it is either *georgianus* (Lea) or *waltonii* Try. If the latter, it would have priority. Tryon (131, p. 197) suggests that the Florida *contectoides* listed by Binney are "perhaps" his *waltonii*.

VIVIPARUS HALEANUS (Lea).

This is apparently a valid species as stated by Tryon. It also occurs in Itchaway-Notchway Creek, Baker Co., Ga., and fossil in a peat bed at Lake Panasoffkee, Fla.

VIVIPARUS INTERTEXTUS (Say).

Hannibal (53, p. 193) has proposed a new subgenus, *Callina*, having this species as the type. The distinction seems to be based on the rounded whorls and perforate shell of this species as compared with the imperforate shell and subcarinate body-whorl of typical *Viviparus*. But as the embryonic

young of *intertextus* are strongly angulated and those of *V. viviparus* are quite acutely carinated the distinction does not seem to be well taken. If, however, for any valid reason, it should be found desirable hereafter to separate the two groups, the name will be available.

VIVIPARA LINEATA (Valenciennes).

W. G. Binney (13, p. 295) from an examination of the type states that this is the *V. bengalensis* (Lam.) from India.

VIVIPARUS MALLEATUS Reeve.

This Japanese species has been introduced into a number of localities on the Pacific coast and has been listed under various names:—

Paludina japonica Wood, Naut., V, 1892, p. 114; Ibid, VI, 1892, p. 51.
Vivipara stelmaphora Stearns, Naut., XV, 1901, p. 91.
Vivipara lecythoides Hannibal, Naut., XXII, 1908, p. 33.
Viviparus malleatus Hannibal, Naut., XXV, 1911, p. 31.

Hannibal (53, p. 194) has made this species the type of a new subgenus, *Cipangopaludina,* which he refers to *Idiopoma* Pils., (98, p. 189) originally proposed as a subgenus, but which he raises to generic rank. As the validity of both of these changes must be ultimately determined by a study of the Asiatic species, they may well be held in abeyance until that has been done.

VIVIPARUS JAPONICUS v. Martens.

This species has been introduced into British Columbia (Pilsbry and Johnson, 110, p. 144) and California (Hannibal, 52, p. 32).

It has also recently appeared in the Muddy River, Brookline, Mass. (Johnson, 60, p. 35 and 61, p. 48).

Hannibal (53, p. 194) refers it to *Idiopoma* Pils.

VIVAPARA MULTICARINATA (Haldeman).

This name was proposed by Haldeman for the *Paludina carinata* Val., which was erroneously stated by the author to be from Mexico, *carinata* having already been used by Swainson for an Indian species of the same genus. W. G. Binney (12, p. 430), states that the types in the Jardin des Plantes, Paris, are labelled in Valenciennes' handwriting "Philippines." It is undoubtedly a form of *V. burroughianus* Lea.

VIVIPARUS WALKERI Pilsbry and Johnson.

Viviparus walkeri Pilsbry and Johnson, Naut., XXVI, 1912, p. 48, pl. XXX, figs. 6-7.

Type locality: Juniper Creek, Lake Co., Fla.

VIVIPARUS WALTONII Tryon.

Vivipara waltonii Tryon, Am. J. of Con., II, 1866, p. 108, pl. 10, fig. 2.
Type locality: St. John's River, Fla.

VIVIPARUS WAREANUS (Shuttleworth).

This species is distinct from *georgianus* Lea.

Genus CAMPELOMA Rafinesque, 1819.

Melanthro W. G. Binney *non* Bowditch.

Pilsbry has recently (105, p. 111) proposed to substitute *Ambloxis* Raf. for *Campeloma* Raf. For the same reasons that I have urged in support of the retention of *Anculosa* Say, it seems to me that the preference should be given to *Campeloma*.

CAMPELOMA DECISUM (Say).

The undescribed forms of this species from Michigan listed as vars. *flava* Currjer MSS. and *melanostoma* Currier MSS. (Walker, 142, p. 138) are of doubtful validity.

Binney is in error in referring the following species to *decisum* as synonyms: *integrum* Say, *geniculum* Con., *milesii* Lea, *obesum* Lewis, *rufum* Hald., and *subsolidum* Anth.

Melantho fecunda mentioned, but purposely left undescribed, by Lewis in 1868 (66, p. 135) and listed as a distinct species in 1869 (67, p. 34) does not seem to be separable from *decisum*, judging from the author's original specimens now in my collection. Call's remark (17, p. 135) that this is the female of *obesum* Lewis is wholly wrong.

CAMPELOMA FLORIDENSE Call.

"*Campeloma floridense* Call MSS." (as synonym of *C. limum*), Call, Bull. Washb. Coll. Lab. of Nat. Hist., I, 1886, p. 159, pl. 6, fig. 7; Pilsbry, Naut., XXX, 1917, p. 42.

Type locality not specified. Apparently restricted to the St. John's River and tributary creeks in Florida.

It has very generally been considered to be the *C. limum* (Anth.).

CAMPELOMA GENICULUM (Con.).

The exact status of this species still remains to be settled. Call at one time considered it a valid species (15a, p. 157), but later (17, p. 134) treated it as a variety of *decisum*. Lewis remarks (71, p. 41) that all the Alabama species exhibit this peculiarity. Under this aspect of the case, the species, to which Conrad's form should be referred, can only be determined by an examination of his original type.

CAMPELOMA INTEGRUM (Say).

Is a valid species and quite distinct from *decisum*.

CAMPELOMA INTEGRUM OBESUM ("Lewis" Tryon).

? Paludina obesa "Lewis" W. G. Binney, L. and F. W. Shells, III, 1865, p. 47, fig. 95.
Melantho obesa Lewis, Am. J. of Con., IV, 1868, p. 134.
Melantho obesus Lewis, Pr. A. N. S. P., 1875, p. 336, pl. XXIII, figs. 4-5.
Vivipara obesa "Lewis" Tryon, Mon., 1870, p. 25, pl. 13, fig. 6.
Type locality: Ohio Canal, Columbus, O., and Michigan.

Tryon seems to have been the first to have formally described this well marked form, although Lewis had already referred to it by that name in his papers on *Melantho* in 1868 and 1869. Binney figured what he supposed to be it, but Lewis seems to think (l. c.) that he did not do so. Binney states that *"Paludina obesa"* is preoccupied, but I have not been able to check the reference. If that is true and Binney's figure represents the true *obesa* of Lewis, his remarks and figure are sufficient to fix that name on the form and consequently it would have to receive a new name.

Typically very distinct, this form seems to bear the same relation to *integrum* that *gibbum* does to *rufum*.

Call's statement (17, p. 135) that Lewis' type of this form is the male and the type of his undescribed *fecunda* the female of the same species is an error.

CAMPELOMA LEWISII Walker.

Campeloma lewisii Walker, Naut., XVIII, 1915, p. 126, pl. V, fig. 3.
Type locality: Yallabusha River, Grenada, Miss.

This is the *Melantho coarctata* of W. G. Binney. For full synonymy see Walker, 154, p. 126.

CAMPELOMA LIMUM (Anthony).

According to Pilsbry (103, p. 43) *Melantho decampii* W. G. Binn. is a synonym of this species, which has been very generally misunderstood. The Florida form usually known by this name is *C. floridense* Call.

CAMPELOMA MILESII (Lea).

Is apparently a valid species. If not, it should be referred to *decisum* rather than to *subsolidum*. See Walker, 146, p. 121.

CAMPELOMA PONDEROSUM COARCTATUM (Lea).

This is the *Paludina coarctata* and *P. incrassata* of Lea and the *Vivipara nolani* of Tryon.

For full synonymy see Walker, 154, p. 125.

CAMPELOMA RUFUM (Haldeman).

Is a valid species.

CAMPELOMA RUFUM GIBBUM (Currier).

Melantho gibba Currier, Am. J. of Con., III, 1867, p. 112, pl. 6, fig. 3.
Type locality: Grattan, Mich.

CAMPELOMA RUFUM GENICULIFORME Pilsbry.

Campeloma rufum geniculiforme Pilsbry, Naut., XXX, 1916, p. 42.
Type locality: Dooley Co., Ga.

CAMPELOMA RUFUM MERIDIONALE Pilsbry.

Campeloma rufum meridionale Pilsbry, Naut., XXX, 1916, p. 42.
Type locality: Crozier's Branch, Cabarrus Co., N. C. Also Little Sugar Creek, N. C. and Georgia.

CAMPELOMA SPILLMANII (Lea).

Paludina spillmanii Lea, Pr. A. N. S. P., 1867, p. 81; Jour. A. N. S. P., VI, 1868, p. 343, pl. 44, fig. 29; Obs., XII, 1868, p. 103, pl. 44, fig. 29.
Lioplax spillmanii Tryon, Mon., 1870, p. 35, pl. 14, fig. 7; pl. 15, fig. 8.
Type locality: Jackson Co., Ala.

Tryon (l. c.) gives the type locality as Jackson Co., Miss. Numerous specimens from several streams near Mooresville, Limestone Co., Ala., collected by Rev. H. E. Wheeler agree with the descriptions and figures given by Lea and Tryon and are *Campelomæ*. The embryonic young are strongly and acutely bicarinated, differing in this respect from all the other species of the genus. The operculum is wholly concentric. These shells agree very exactly with the cotypes of *C. decampii* W. G. Binn. in the DeCamp collection. If this identification and approximation are correct, *spillmanii* Lea will follow *decampii* into the synonymy of *C. limum* (Anth.).

CAMPELOMA SUBSOLIDUM (Anthony).

Is a valid species. Whether the *Paludina exilis* of Anthony is a sexual form as believed by Lewis and others or an individual or local mutation is unsettled. The fact that it has not been found in southwestern Michigan, where the species is a common one would seem to cast a doubt on its being a sexual variation.

Genus LIOPLAX Troschel, 1856.

LIOPLAX ELLIOTTII (Lea).

Is a valid species.

LIOPLAX PILSBRYI Walker.

Lioplax pilsbryi Walker, Naut., XVIII, 1905, p. 133, pl. IX, figs. 1-3.
Type locality: Chipola River, Fla. Also Econfine River and Mud Creek, Fla.

Genus TULOTOMA Haldeman, 1840.

TULOTOMA ANGULATA (Lea).

The opinion of Lewis (71, p. 24) and Wetherby (164, p. 207) that this is specifically distinct from *magnifica* Con. is no doubt correct.

TULOTOMA COOSAENSIS (Lea).

This species described as a *Paludina* and referred to *Vivipara* by Binney and to *Lioplax* by Tryon (132, p. 36) is a *Tulotoma* as stated by Wetherby (164, p. 212).

Family VALVATIDÆ.

Genus VALVATA O. F. Müller, 1774.

VALVATA BICARINATA Lea.

Is a valid species. See Walker, 146, p. 124 and 147, p. 29.

VALVATA BICARINATA CONNECTANS Walker.

Valvata bicarinata connectans Walker, Naut., XX, 1906, p. 30.
Type locality: Lake Michigan, New Buffalo, Mich.

VALVATA BICARINATA NORMALIS Walker.

Valvata bicarinata normalis Walker, Naut., XV, 1902, p. 125, fig. 5.
Type locality: Not specified.
Habitat: Muscatine, Ia. and Utica, Ills.

VALVATA BICARINATA PERDEPRESSA Walker.

Valvata bicarinata perdepressa Walker, Naut., XX, 1906, p. 30, pl. I, figs. 15-16.
Type locality: Lake Michigan, Michigan City, Ind.

VALVATA CALLI Hannibal, Naut., XXIII, 1910, p. 107.

Type locality: Marl-deposit, Upper Lahontan Quaternary, Summer Lake, Or.

VALVATA HUMERALIS CALIFORNICA Pils.

Valvata humeralis californica Pilsbry, Naut., XXII, 1908, p. 82.
Type locality: Bear Lake, San Bernardino Co., Cal.

VALVATA LEWISI Currier.

Valvata striata Lewis, Pr. A. N. S. P., 1856, p. 260; *non striata* Philippi, 1836-1844; Binney, L. and F. W. Shells, Pt. III, 1865, p. 13, fig. 18.
Valvata lewisi Currier, Kent Sci. Inst. Misc. Pub., 1868, p. 9.
Type locality: Little Lakes, N. Y.

VALVATA LEWISI HELICOIDEA Dall.

Valvata lewisi helicoidea Dall, Rep. Harriman Exp., XIII, 1905, p. 123, pl. II, figs. 1-2.
Type locality not specified.
Range: "With the type form, to some extent everywhere, but especially toward the Northwest".

VALVATA MERGELLA West.

Valvata mergella Westerlund, Vega Exped. Vetens. Iakt., IV, 1885, p. 209, pl. V, figs. 22 a-d.
Type locality: Port Clarence, near Bering Strait, Alaska.

VALVATA OBTUSA Drap.

This European species has been listed from the mouth of the Genessee River, N. Y., by Baker (3, p. 71).

VALVATA PISCINALIS Müller.

This European species has recently been found by Latchford (65, p. 10) at Honisher Bay, Toronto, Ont.

VALVATA SINCERA DANIELSI Walker.

Valvata sincera danielsi Walker, Naut., XX, 1906, p. 28, pl. I, figs. 10-11.
Type locality: Cannon Lake, Rice Co., Minn.

VALVATA SINCERA NYLANDERI Dall.

Valvata (*sincera* var.?) *nylanderi* Dall, Rep. Harriman Exp., XIII, 1905, p. 122.
Type locality: Aroostook Co., Me.

VALVATA TERRÆ-NOVÆ Ferussac.

Type locality: ?

Specimens under this name are in the Museum of Paris according to Binney (12, p. 430), but it does not appear to have ever been described.

VALVATA TRICARINATA Say.

This species is the type (by designation) of the subgenus *Tropidina* H. and A. Adams, 1858, but as it is based upon the carinated whorls of the typical form and the species varies from ecarinate to tricarinate, it does not seem worthy of recognition.

VALVATA TRICARINATA BASALIS Vanatta.

Valvata tricarinata basalis Vanatta, Naut., XXVIII, 1915, p. 105, fig.
Type locality: Hudson River, N. Y.

VALVATA TRICARINATA INFRACARINATA Vanatta.

Valvata tricarinata infracarinata Vanatta, Naut., XXVIII, 1915, p. 104, fig.
Type locality: White Pond, N. J.

VALVATA TRICARINATA PERCONFUSA Walker.

Valvata tricarinata confusa Walker, Naut., XV, 1902, p. 124, fig. 2, *non V. confusa West.* (1897).
Valvata tricarinata perconfusa Walker, Naut., XXXI, 1917, p. 36.
Type locality not specified.

VALVATA UTAHENSIS Call.

Valvata sincera utahensis Call, Bull. U. S. Geol. Surv., No. 11, 1884, p. 44, pl. VI, figs. 1-3.
Valvata utahensis Call, Pr. Davenport A. N. S., V, 1886, p. 4, pl. I, figs. 1-3.
Type locality: Utah Lake, Utah.

Family AMNICOLIDÆ.

Subfamily BYTHININÆ Stimpson, 1865.

Genus BYTHINIA Leach, 1818.

BYTHINIA PERFECTA Frauenfeld.

Bythinia perfecta Frauenfeld, Verh. der k. k. zool-bot. Ges. Wien, 1862, p. 1154; Ibid, 1865, p. 527, pl. IX.
Type locality: Columbia, North America.

Frauenfeld states that as the types are without the opercula, he could not tell whether the species was a *Bythinia* or an *Amnicola*. If the locality is correct, it is surely not a *Bythinia*. It may be a *Fluminicola*.

BYTHINIA TENTACULATA (L.).

This well known European species has been introduced by commerce and has spread from the Hudson west to Lake Michigan.

Subfamily AMNICOLINÆ Gill, 1871.

Genus AMNICOLA Gould and Haldeman, 1840.

Amnicola augustina Pilsbry.

Amnicola augustina Pilsbry, Naut., XVII, 1904, p. 113; Walker, Naut., XIX, 1906, p. 117, pl. V, figs. 13-14.

Type locality: St. Augustine, Fla. Also at Tuscumbia, Ala., and fossil in a peat deposit at Lake Panasoffkee, Fla.

Amnicola bakeriana Pilsbry, Naut., XXXI, 1917, p. 44.

Type locality: Oneida Lake, N. Y.

Amnicola bakeriana nimia Pilsbry.

Amnicola bakeriana nimia Pilsbry, Naut. XXXI, 1917, p. 45.

Type locality: Oneida Lake, N. Y.

Amnicola clarkei Pilsbry.

Amnicola clarkei Pilsbry, Naut., XXXI, 1917, p. 45.

Type locality: Oneida Lake, N. Y.

Amnicola comalensis Pilsbry and Ferriss.

Amnicola comalensis Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 171, fig. 37; Pilsbry, Naut., XIII, 1910, p. 98.

Type locality: Comal Creek, New Braunfels, Texas. Also Guadalupe River at the same place.

Amnicola deserta Pilsbry.

Amnicola deserta Pilsbry, Naut., XXIX, 1916, p. 111.

Type locality: Washington Co., Utah.

Amnicola ferruginea Calkins.

Amnicola ferruginea Calkins, Valley Nat., II, 1880, p. 6, text fig.

Type locality: Calumet River, Ill.

Baker (4, p. 331) refers this to *A. limosa* Say.

Amnicola floridana Frauenfeld.

Amnicola floridana Frauenfeld, Verh. der k. k. zool.-bot. Ges. Wein., 1863, p. 1028; Ibid, 1865, p. 529, pl. X.

Type locality: East Florida.

AMNICOLA FLORIDANA CONVEXA Pilsbry.

Amnicola floridana convexa Pilsbry, Trans. Wag. Free Inst. Sci., III, Pt. II, 1892, p. 338.

Type locality: Pliocene marl of the Caloosahatchie and Shell Creek, Fla.; also living in the fresh-water of Florida at the present time.

AMNICOLA HARPERI Dall.

Amnicola harperi Dall, Naut., XXIV, 1913, p. 2.

Type locality: Marl deposit, Lake Panasoffkee, Fla.

AMNICOLA JOHNSONI Pilsbry.

Amnicola johnsoni Pilsbry, Naut., XIII, 1899, p. 21.

Type locality: St. Augustine, Fla. Also fossil at Lake Panasoffkee, Fla.

AMNICOLA LIMOSA (Say).

Includes *A. ferruginea* Calkins according to Baker.

The figure given for this species by Dall (32, p. 117, fig. 84) is incorrect, being a copy of Binney's figure (No. 165) of *A. pallida* Hald.

AMNICOLA LIMOSA PORATA (Say).

Includes *A. orbiculata* Lea as a synonym according to Pilsbry (92, p. 44).

AMNICOLA LUSTRICA Pilsbry.

Amnicola lustrica Pilsbry, Naut., IV, 1890, p. 53.

Type locality not specified.

Range: "New York to Illinois and Minnesota".

AMNICOLA MICROCOCCUS Pilsbry.

Amnicola micrococcus Pilsbry, N. Am. Fauna, No. 7, Pt. II, 1893, p. 277, fig. 1; U. S. Nat. Mus., XXIV, 1901, p. 286, fig. 4.

Type locality: Oasis Valley, Nev. Also Death Valley, Inyo Co., Cal.

AMNICOLA MILIARIA Parreys.

Frauenfeld (40, p. 1027) states that in the Cuming Collection there is a set of this European species labelled "Spring Garden Lake, East Florida". He considers the shells to belong to this species without doubt, so that as he suggests there has probably been a mixing of labels.

AMNICOLA MISSOURIENSIS Pilsbry.

Amnicola missouriensis Pilsbry, Naut., XII, 1898, p. 43.

Type locality: Carter Co., Mo.

AMNICOLA NEOMEXICANA Pilsbry.

Amnicola neomexicana Pilsbry, Naut. XXIX, 1916, p. 111.
Type locality: Socorro, New Mexico.

AMNICOLA NUTTALLIANA "Lea" Frauenfeld.

Amnicola nuttalliana Frauenfeld, Verh. der k. k. zool.-bot. Ges. Wien., 1863, p. 1029.

The form thus listed by Frauenfeld from Silver Spring, Fort King, Fla., is probably *Gillia wetherbyi* Dall, as suggested by Dall (28, p. 258).

AMNICOLA OLIVACEA Pilsbry.

Amnicola olivacea Pilsbry, Naut., VIII, 1895, p. 115.
Type locality: Huntsville, Ala.

AMNICOLA ONEIDA Pilsbry.

Amnicola oneida Pilsbry, Naut., XXXI, 1917, p. 46.
Type locality: Oneida Lake, N. Y.

AMNICOLA PALLIDA Haldeman.

The figure given by Dall for this species (32, p. 117, fig. 85) is a copy of Binney's figure (No. 168) of *A. cincinnatiensis.*

AMNICOLA PARVA Lea.

Is a valid species. See Pilsbry, 92, p. 44.

AMNICOLA PILSBRYI Walker.

Amnicola parva Marsh, Con. Ex., II, 1888, p. 91.
Amnicola pilsbryi Walker, Naut., XIX, 1906, p. 116, pl. V, figs. 11 and 16.
Type locality: Rockford, Ills.

AMNICOLA SANCTIJOHANNIS Pilsbry.

Amnicola sanctijohannis Pilsbry, Naut., XIII, 1899, p. 20.
Type locality: St. John's River, Astor, Fla. Also Silver Spring Run, Marion Co., and Wekiva River, Fla.

AMNICOLA SCHROKINGERI Frauenfeld.

Amnicola schrokingeri Frauenfeld, Verh. der k. k. zool.-bot. Ges. Wien, 1863, p. 1030; Ibid, 1865, p. 528, pl. X.
Type locality: Massachusetts.

If the specimens from several localities in Maine are correctly identified, this species seems to be distinct from *limosa,* to which it is referred by Tryon (132, p. 52).

Closely related to, but very much smaller than *A. winkleyi* according to Pilsbry (102, p. 1).

AMNICOLA WALKERI Pilsbry.

Amnicola walkeri Pilsbry, Naut., XII, 1898, p. 43; Walker, Naut., XIX, 1906, p. 117, pl. V, fig. 12.
Type locality: High Island Harbor, Beaver Ids., Lake Michigan.
Range: Upper St. Lawrence drainage from Ottawa, Ont., to Lake Michigan.

AMNICOLA WINKLEYI Pilsbry.

Amnicola winkleyi Pilsbry, Naut., XXVI, 1912, p. 1, pl. I, figs. 9-10.
Type locality: Saco, Me.

Section CINCINNATIA Pilsbry, 1891.

AMNICOLA CINCINNATIENSIS (Anth.).

Amnicola scarboroughi Tryon MSS. is a synonym according to Tryon (132, p. 54).

Baker's remark (4, p. 336), that Binney's fig. 162 is an error is incorrect. That figure does not represent this species, but is the radula of *A. sayana* Anth. (*Pomatiopsis cincinnatiensis* Lea). The same author (loc. cit., pp. 335 and 343) has reversed the synonymy of the two species, which explains his remark that Haldeman's figures of the two species are interchanged.

The figure given for this species by Dall (32, p. 118, fig. 87) is also incorrect, being Binney's fig. 166 of *A. limosa*.

AMNICOLA EMARGINATA (Kuster).

Paludina obtusa Lea, Pr. Am. Phil. Soc., II, p. 34, (1841), *non P. obtusa* Phil. (1837).
Pauldina emarginata Kuster, Con. Cab., Paludina, 1852, p. 50, pl. 10, figs. 3-4.
Cincinnatia binneyana Hann., Pr. Mal. Soc. Lond., X, 1912, p. 190.

There seems to be no valid ground for the new name proposed by Hannibal.

AMNICOLA PERACUTA Pilsbry and Walker.

Amnicola peracuta Pilsbry and Walker, Pr. A. N. S. P., 1889, p. 88, pl. III, fig. 20.
Type locality: Spivey's Lake, Navarro Co., Texas.

Genus PALUDESTRINA d'Orbigny, 1841.

Bythinella Moq.-Tand, 1851.
Stimpsonia Clessin, Mal. Blätt., XXV, 1878, p. 151.

Except as noted, all the species referred to *Bythinella* by Binney belong to this genus.

PALUDESTRINA ACUTISSIMA "Whit." (Frauenfeld).

? Amnicola acutissima "Whit.", Frauenfeld, Verh. der k. k. Zool.-bot. Ges. Wien, 1863, p. 207.
Hydrobia acutissima "Whit.", Frauenfeld, Ibid, 1863, p. 1021.
Type locality: ?

Frauenfeld queries as to who "Whit." is. The fact that *Pal. emarginata* and other North American species are in the Cuming Collection named by "Whit." makes it a possibility that this is also an American species. It is possible that "Whit." stands for T. J. Whittemore, who was a well known collector in Massachusetts in 1840.

PALUDESTRINA ÆQUICOSTATA (Pilsbry).

Bythinella æquicostata Pilsbry, Pr. A. N. S. P., 1889, p. 86, pl. III, fig. 16.
Type locality: Sumpter Co. and Haulover Canal, Fla.

PALUDESTRINA ALDRICHI (Call and Beecher).

Bythinella aldrichi Call and Beecher, Bull. Wash. Coll., I, 1886, p. 190, pl. VII, figs. 11-14.
Type locality: Tributary of Black River, Reynolds Co., Mo.

PALUDESTRINA BREVISSIMA (Pilsbry).

Bythinella brevissima Pilsbry, Naut., IV, 1890, p. 64.
Type locality: Haulover Canal, Indian River, Fla.

"HYDROBIA" CALIFORNICA Tryon.

Hydrobia californica Tryon, Am. J. of Con., I, 1865, p. 221, pl. 22, fig. 11. Is an *Assimenia* according to Pilsbry (96, p. 123).

PALUDESTRINA CORRIGATA (Frauenfeld).

Hydrobia corrigata Frauenfeld, Verh. der k. k. Zool.-bot. Ges. Wien, 1863, p. 1021; Ibid, 1865, p. 525, pl. VIII.
Type locality: Boston, Mass.

PALUDESTRINA DIABOLI Pilsbry and Ferriss.

Paludestrina diaboli Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 170, fig. 36.
Type locality: Devil's River, Val Verde, Texas. Also Rio San Filipe in the same county.

PALUDESTRINA HEMPHILLI (Pilsbry).

Bythinella hemphilli Pilsbry, Naut., IV, 1890, p. 63.
Type locality: Kentucky Ferry, Snake River, Idaho.

PALUDESTRINA IMITATOR Pilsbry.

Paludestrina imitator Pilsbry, Naut., XII, 1899, p. 124.
Type locality: Santa Cruz, Cal.

PALUDESTRINA LONGINQUA (Gould).

Amnicola longinqua Gould, Pr. B. S. N. H., V, 1855, p. 130.
Pomatiopsis intermedia Tryon, Am. J. of C., I, 1865, p. 220, pl. 22, fig. 8.
Bythinella intermedia Tryon, Mon., 1870, p. 49.
See Pilsbry, 96, p. 122.

PALUDESTRINA MINUTA (Totten).

Turbo minutus Totten, Am. Jour. Sci., O. S., XXVI, 1834, p. 369, fig. 6.
Cingula minuta Gould, Rep. Invert. Mass., 1841, p. 265, fig. 171.
Type locality: Mass. and Rhode Island.
This species is referred to *Paludestrina* by Pilsbry (99, p. 90).

PALUDESTRINA MONAS Pilsbry.

Paludestrina monas Pilsbry, Naut., XIII, 1899, p. 21.
Type locality: Wekiva River, Fla.

PALUDESTRINA MONROENSIS (Dall).

Bythinella monroensis Dall, Pr. U. S. Nat. Mus., VIII, 1885, p. 256, pl. 17, fig. 99.
Type locality: Brook from Benson's mineral spring into Lake Monroe, Enterprize, Fla.

PALUDESTRINA NICKLINIANA (Lea).

This species is the type of Clessin's genus *Stimpsonia*.

PALUDESTRINA NICKLINIANA ATTENUATA (Haldeman).

Amnicola attenuata Hald., Mon., pt. 4, 1842, p. 3 of wrapper; Mon., 1844, p. 22, pl. I, fig. 13.
Bythinella attenuata Binney, L. and F. W. Shells, pt. III, 1865, p. 68, fig. 132.

PALUDESTRINA PROTEA (Gld.).

Amnicola protea Gould, Pr. Bost. S. N. H., V, March, 1855, p. 129.
Melania exigua Conrad, Pr. A. N. S. P., April, 1855, p. 269.
Tryonia protea Binney, L. and F. W. Shells, III, 1865, p. 72, fig. 140.
Bythinella protea Stearns, N. Am. Fauna, No. 7, Pt. II, 1893, p. 278.
Paludestrina protea Stearns, Pr. U. S. Nat. Mus., XXIV, 1901, p. 277, pl. XIX-XXI.

Hydrobia seemani Frauenfeld, Verh. der k. k. zool.-bot. Gesell. Wien, 1863, p. 1025; Ibid, 1865, p. 525, pl. VIII.
Bythinella seemani Pilsbry, N. Am. Fauna, No. 7, Pt. II, 1893, p. 278.

For an elaborate and fully illustrated account of the variation of this protean species, see Stearns' paper cited above.

PALUDESTRINA SALSA Pilsbry.

Paludestrina salsa Pilsbry, Naut., XIX, 1905, p. 90, pl. III, fig. 10.
Type locality: Cohasset, Mass., in brackish water.

PALUDESTRINA STEARNSIANA Pilsbry.

Paludestrina stearnsiana Pilsbry, Naut., XII, 1899, p. 124.
Type locality: Oakland, Cal. Also Marin, Tuolumne, Contra Costa and Santa Cruz Counties, Cal. Also Ash Canyon and Tanner Canyon, Huachuca Mts., Ariz., Pilsbry and Ferriss (106a, p. 516).

Genus TRYONIA Stimpson, 1865.

Pilsbry (96, p. 122), states that *Tryonia* is probably only a subgenus of *Paludestrina*.

TRYONIA CLATHRATA Stimpson.

This species, described from fossil specimens, has been found living in the Pahranagat Valley, Nev. (Stearns, 123, p. 281).

Genus PYRGULOPSIS Call and Pilsbry, 1886.

Pyrgulopsis Call and Pilsbry. Pr. Davenport A. N. S., V, 1886, p. 9.
Type: *Pyrgula nevadensis* Stearns.

PYRGULOPSIS LETSONI (Walker).

Amnicola letsoni Walker, Naut., XIV, p. 113 (1901); Letson, Bull. Buffalo Soc. Nat. Sci., VII, 1901, p. 241, fig. 165.
Type locality: Post-Glacial deposit, Goat Island, Niagara River, N. Y. Also fossil at Bowmanville, Ills. and living at La Plaisance Bay, Lake Erie, Monroe Co., Mich.

Goodrich (*in lit.*) has suggested that this species should be referred to *Pyrgulopsis* and I fully agree with him.

PYRGULOPSIS NEVADENSIS (Stearns).

Pyrgula nevadensis Stearns, Pr. A. N. S. P., 1883, p. 173, text fig.; Call and Beecher, Am. Nat., XVIII, 1884, pp. 851-855; Call and Pilsbry, Pr. Davenport Acad. Nat. Sci., V, 1886, p. 10, pl. II, figs. 1-10.
Type locality: Walker and Pyramid Lakes, Nev.

PYRGULOPSIS SCALARIFORMIS (Wolf).

Pyrgula scalariformis Wolf, Am. J. of Con., V, 1869, p. 198, pl. 17, fig. 3.
Pyrgulopsis scalariformis Shimek, Bull. Lab. Nat. Hist. St. Univ. Ia., II, 1892, p. 168, pl. xiii, figs. 3a-d.
Pyrgula scalariformis mississippiensis Pilsbry, Am. Nat., 1886, p. 5. No description.
Pyrgulopsis mississippiensis Call and Pilsbry, Pr. Davenport A. N. S., V, 1886, p. 13, pl. II, figs. 14-16; Walker, Naut., XIX, 1906, p. 116, pl. 5, fig. 15.
Type locality: Illinois River, Tazwell Co., Ills. Holocene.

According to Shimek (l. c.) *mississippiensis* is a synonym of *scalariformis*.

PYRGULOPSIS OZARKENSIS Hinkley,

Pyrgulopsis ozarkensis Hinkley, Pr. U. S. Nat. Mus., 49, 1915, p. 588, pl. 78, fig. 2.
Type locality: North Fork of White River, above Norfolk, Ark.

PYRGULOPSIS SHELDONI (Pilsbry).

Amnicola sheldoni Pilsbry, Naut., IV, 1890, p. 52.
Type locality: Lake Michigan, Racine, Wis.

This species seems to be a *Pyrgulopsis* rather than an *Amnicola*.

PYRGULOPSIS WABASHENSIS Hinkley.

Pyrgulopsis wabashensis Hinkley, Naut., XXI, 1908, p. 117.
Type locality: Wabash River, The Chains, Posey Co., Ind.

Genus POTAMOPYRGUS Stimpson, 1865.

POTAMOPYRGUS CORONATUS (Pfeiffer).

Paludina coronata Pfeiffer, Wiegm. Archiv., I, 1840, p. 253.
Type locality: Cuba.

Listed from Miami River, Fla., by Rhoads (113, p. 47).

POTAMOPYRGUS SPINOSUS (Call and Pilsbry).

Pyrgulopsis spinosa Call and Pilsbry, Pr. Davenport A. N. S., V., 1886, p. 14, pl. II, fig. 17-19.
Hydrobia texana Pilsbry, Ibid, V, 1886, p. 33, pl. III, fig. 1-6.
Type locality: *spinosus*, Comal Creek, Texas; *texana*, Guadelupe River and Comal Creek, Tex.

According to Pilsbry (91, p. 327) this species is a *Potamopyrgus* and is doubtfully distinct from *coronatus*. *Texana* is the ecarinate form.

Genus LITTORIDINA Souleyet, 1852.

LITTORIDINA MONROENSIS (Frauenfeld).

Hydrobia monroensis Frauenfeld, Verh. der k. k. Zool.-bot. Gesell. Wien, 1863, p. 1023; Pilsbry, Pr. A. N. S. P., 1889, p. 88, pl. III, figs. 17-19.
Bythinella monroensis Tryon, Mon. 1870, p. 48.
Type locality: Lake Monroe, Fla.

The generic position of this species, which was doubtfully referred to *Littoridina* by Pilsbry (94, p. 22) has since been confirmed by him. It is not the *Bythinella monroensis* of Dall (28, p. 256).

Subfamily LYTHOGLYPHINÆ Fischer, 1885.

Genus COCHLIOPA Stimpson, 1865.

COCHLIOPA ROWELLI Tryon.

The occurrence of this species in California is considered doubtful by Pilsbry (100, p. 91) and by Pilsbry and Ferriss (106, p. 172). Rowell however insists that the types were collected by him "near Baulinas Bay (not Clear Lake), Marin Co., Cal." (114, p. 10).

It is known to inhabit Nicaragua.

COCHLIOPA RIOGRANDENSIS Pilsbry and Ferriss.

Cochliopa riograndensis Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 171, pl. IX, figs. 10-13.
Type locality: Rio San Filipe, near the Rio Grande, Val Verde Co., Texas. Also Devil's River in the same county.

Genus FLUMINICOLA Stimpson, 1865.

Hannibal (53, p. 186) has proposed a new subgenus *Heathella*, "readily distinguished by its globose form," having *F. seminalis* Hds. as the type and including *F. fusca, merriami, erythropoma, columbiana* and *minutissima*.

FLUMINICOLA COLUMBIANA Hemphill.

Fluminicola columbiana "Hemphill," Pilsbry, Naut., XII, 1899, p. 125; Pr., U. S. Nat. Mus., XXIV, 1901, p. 285, fig. 3.
Type locality: Columbia River, Washington, near Wallula and near mouth of Snake River; Snake River, near Weiser, Idaho.

FLUMINICOLA ERYTHROPOMA Pilsbry.

Fluminicola fusca minor Stearns, N. Amer. Fauna, No. 7, Pt. II, 1893, p. 282. No description.
Fluminicola erythropoma Pilsbry, Naut., XII, 1899, p. 125.
Type locality: Ash Meadows, Nye Co., Nev.

FLUMINICOLA MERRIAMI Pilsbry and Beecher.

Fluminicola merriami Pilsbry and Beecher, Naut., V, 1892, p. 143; Stearns, N. Am. Fauna, No. 7, pt. II, 1893, p. 282, fig. 2.
Type locality: Pahranagat Valley, Nev.

FLUMINICOLA MINUTISSIMA Pilsbry.

Fluminicola minutissima Pilsbry, Naut., XXI, 1907, p. 76, pl. IX, fig. 1.
Type locality: Price Valley, Weiser Canyon, Washington Co., Idaho.

FLUMINICOLA MODOCI Hannibal.

Fluminicola modoci Hannibal, Pr. Mal. Soc. Lond., X, 1912, p. 187, pl. VII, fig. 30.
Type locality: Fletcher's Spring, south end of Goose Lake, Cal.

FLUMINICOLA NEVADENSIS Walker.

Fluminicola nevadensis Walker, Occ. Pap. Mus. Zool., Univ. Mich., No. 29, 1916, p. 6, text-fig.
Type locality: Cortez foot-hills, Humboldt Valley, Elko Co., Nev.

FLUMINICOLA SEMINALIS (Hinds).

Paludina seminalis Hinds, Voy. Sulphur, 1844, p. 59, pl. 16, fig. 22.
Lithoglyphus cumingii Frauenfeld, Verh. der k. k. Zool.-bot. Ges. Wien., 1863, p. 195; Ibid, 1865, p. 530, pl. XI.
Amnicola tubiniformis Tryon, A. J. of Con., I, 1865, p. 219, pl. 22, fig. 5.
Type locality: *seminalis,* Sacramento River, Cal.
cumingii, California.
turbiniformis, Crane Lake Valley and Surprise Valley, Cal.
This synonymy is according to Pilsbry (96, p. 123).

FLUMINICOLA SEMINALIS DALLI (Call).

Amnicola dalli Call, Bull. U. S. Geol. Surv., No. XI, 1884, p. 45, pl. VII, figs. 4-6.
Fluminicola seminalis dalli Pilsbry, Naut., XIII, 1899, p. 123.
Type locality: Mountain streams near Pyramid Lake, Nev.

Genus SOMATOGYRUS Gill, 1863.

For a description of the peculiar apical sculpture of this genus, see Walker, 156.

SOMATOGYRUS ALDRICHI Walker.

Somatogyrus aldrichi Walker, Naut., XIX, 1901, p. 114, pl. V, fig. 9.
Type locality: Coosa River, Chilton Co., Ala.

SOMATOGYRUS AMNICOLOIDES Walker.

Somatogyrus amnicoloides Walker, Naut., XXIX, 1915, p. 52, fig. 3.
Type locality: Ouachita River, Arkadelphia, Ark.

SOMATOGYRUS AUREUS Tryon.

Somatogyrus aureus Tryon, A. J. of Con., I, 1865, p. 220, pl. 22, fig. 9.
Type locality: Tennessee River.

SOMATOGYRUS BIANGULATUS Walker.

Somatogyrus biangulatus Walker, Naut., XIX, 1906, p. 99, pl. V, fig. 6.
Type locality: Tennessee River, Florence, Ala.

SOMATOGYRUS CONSTRICTUS Walker.

Somatogyrus constrictus Walker, Naut., XVII, 1904, p. 135, pl. V, fig. 3.
Type locality: Coosa River, Wetumpka, Ala.

SOMATOGYRUS COOSAENSIS Walker.

Somatogyrus coosaensis Walker, Naut., XVII, 1904, p. 137, pl. V, figs. 6-8.
Type locality: Coosa River, Wetumpka, Ala.

SOMATOGYRUS CRASSILABRIS Walker.

Somatogyrus crassilabris Walker, Naut., XXIX, 1915, p. 53, fig. 4; Hinkley, Pr. U. S. Nat. Mus., XLIX, 1915, p. 589, pl. 78, fig. 1.
Type locality: North Fork of White River, Norfolk, Ark.

SOMATOGYRUS CRASSUS Walker.

Somatogyrus crassus Walker, Naut., XVII, 1904, p. 138, pl. V, figs. 11-12.
Type locality: Coosa River, Wetumpka, Ala.

SOMATOGYRUS CURRIERIANUS (Lea).

Amnicola currieriana Lea, Pr. A. N. S. P., 1863, p. 118; Jour. A. N. S. P., VI, 1866, p. 186, pl. XXII, fig. 118; Lea, Obs., XI, 1866, p. 142, pl. XXII, fig. 118.
Somatogyrus currierianus Walker, Naut., XVII, 1904, p. 137, pl. II, figs. 8-9.
Type locality: Huntsville, Ala.

SOMATOGYRUS DECIPIENS Walker.

Somatogyrus decipiens Walker, Naut., XXII, 1909, p. 80, pl. I, figs. 10-11.
Type locality: Coosa River, The Bar, Chilton Co., Ala.

SOMATOGYRUS EXCAVATUS Walker.

Somatogyrus excavatus Walker, Naut., XIX, 1906, p. 100, pl. V, fig. 7.
Type locality: Shoal Creek, Florence, Ala.

SOMATOGYRUS GEORGIANUS Walker.

Somatogyrus georgianus Walker, Naut., XVII, 1904, p. 139, pl. V, fig. 13.
Type locality: Chattooga River, Chattooga Co., Ga.

SOMATOGYRUS HENDERSONI Walker.

Somatogyrus hendersoni Walker, Naut., XXII, 1909, p. 87, pl. VI, fig. 2.
Type locality: Coosa River, Duncan's Riffle, Chilton Co., Ala.

SOMATOGYRUS HINKLEYI Walker.

Somatogyrus hinkleyi Walker, Naut., XVII, 1904, p. 135, pl. V, figs. 1-2; Naut., XXII, 1909, p. 87, pl. VI, fig. 8-9.
Type locality: Coosa River, Wetumpka, Ala.

SOMATOGYRUS HUMEROSUS Walker.

Somatogyrus humerosus Walker, Naut., XIX, 1906, p. 98, pl. V, fig. 2.
Type locality: Tennessee River, Florence, Ala.

SOMATOGYRUS INTEGER (Say).

Includes *Paludina fontinalis* Phil. erroneously referred to *subglobosus* by Binney. Both *integer* and *fontinalis* are referred to *Lithoglyphus* by Frauenfeld (39, pp. 194 and 179).

SOMATOGYRUS NANUS Walker.

Somatogyrus nanus Walker, Naut., XVII, 1904, p. 136, pl. V, fig. 4.
Type locality: Coosa River, Wetumpka, Ala.

SOMATOGYRUS OBTUSUS Walker.

Somatogyrus obtusus Walker, Naut., XVII, 1904, p. 138, pl. V, fig. 10.
Type locality: Coosa River, Farmer, Ala.

SOMATOGYRUS PARVULUS Tryon.

Somatogyrus parvulus Tryon, A. J. of Con., I, 1865, p. 221, pl. 22, fig. 10.
Type locality: Powell's River, Tenn.

Binney's figure of "*Gillia* sp?" (L. and F. W. Shells, III, p. 115, fig. 230) is this species according to Tryon (131, p. 198).

SOMATOGYRUS PENNSYLVANICUS Walker.

Somatogyrus pennsylvanicus Walker, Naut., XVII, 1904, p. 140, pl. V, figs. 15-16; Naut., XIX, 1906, p. 116, pl. 5, figs. 17-18.

Type locality: Columbia, Pa. Also Potomac River, Harper's Ferry, Va.

SOMATOGYRUS PILSBRYANUS Walker.

Somatogyrus pilsbryanus Walker, Naut., XVII, 1904, p. 142, pl. V, figs. 20-21.

Type locality: Tallapoosa River, Tallassee, Ala.

SOMATOGYRUS PUMILUS (Conrad).

Anculotus pumilus Conrad, New F. W. Shells, 1834, p. 62; Binney, L. and F. W. Shells, III, 1865, p. 80.

Anculosa pumila Conrad, A. J. of Con., II, 1866, p. 278, pl. XV, fig. 5.

Somatogyrus pumilus Walker, Naut., XIX, 1906, p. 115, pl. V, fig. 10.

Type locality: Black Warrior River, Ala. Also Cahatchee Creek, Shelby Co., Ala.

In his original description, Conrad quotes his species from Bayou Teche, La., but for some reason did not in his subsequent one in 1866.

SOMATOGYRUS PYGMÆUS Walker.

Somatogyrus pygmæus Walker, Naut., XXII, 1909, p. 88, pl. VI, fig. 3.

Type locality: Coosa River, The Bar, Chilton Co., Ala.

SOMATOGYRUS QUADRATUS Walker.

Somatogyrus quadratus Walker, Naut., XIX, 1906, p. 98, pl. V, figs. 3-4.

Type locality: Tennessee River, Florence, Ala.

SOMATOGYRUS SARGENTI Pilsbry.

Somatogyrus sargenti Pilsbry, Naut., VIII, 1895, p. 102; Walker, Naut., XVII, 1904, p. 139, pl. V, fig. 14.

Type locality: Mud Creek, a tributary of the Tennessee River, Ala.

SOMATOGYRUS STRENGI Pilsbry and Walker.

Somatogyrus strengi Pilsbry and Walker, Naut., XIX, 1906, p. 99, pl. V, fig. 5.

Type locality: Tennessee River, Florence, Ala. Also Wabash River, Posey Co., Ind.

SOMATOGYRUS SUBGLOBOSUS (Say).

Subglobosus (1825) has priority over *isogonus* (1829). *Paludina fontinalis* Phil. doubtfully referred to this species by Binney is a synonym of *integer* Say.

SOMATOGYRUS SUBSTRIATUS Walker.

Somatogyrus substriatus Walker, Naut., XIX, 1906, p. 97, pl. V, fig. 5.
Type locality: Tennessee River, Florence, Ala.

SOMATOGYRUS TENNESSEENSIS Walker.

Somatogyrus tennesseensis Walker, Naut., XIX, 1906, p. 114, pl. V, fig. 8.
Type locality: Shoal Creek, Florence, Ala.

SOMATOGYRUS TROTHIS Doherty.

Somatogyrus trothis Doherty, Quar. J. of Con., I, 1878, p. 341, pl. IV, fig. 1.
Type locality: Ohio River, Campbell Co., Ky.

SOMATOGYRUS UMBILICATUS Walker.

Somatogyrus umbilicatus Walker, Naut., XVII, 1904, p. 137, pl. V, fig. 5.
Type locality: Coosa River, Wetumpka, Ala.

SOMATOGYRUS VIRGINICUS Walker.

Somatogyrus virginicus Walker, Naut., XVII, 1904, p. 141, pl. V, figs. 18-19.
Type locality: Barnard's Ford, Rapidan River, Va.

SOMATOGYRUS WALKERIANUS Aldrich.

Somatogyrus walkerianus Aldrich, Naut., XVIII, 1905, p. 140, text-fig.
Type locality: Conecut (Conecuh?) River, Escambia Co., Ala.

SOMATOGYRUS WHEELERI Walker.

Somatogyrus wheeleri Walker, Naut., XXIX, 1915, p. 51, figs. 1-2.
Type locality: Ouachita River, Arkadelphia, Ark.

Genus GILLIA Stimpson, 1865.

GILLIA WETHERBYI (Dall).

Hydrobia ? wetherbyi Dall, Pr. U. S. Nat. Mus., 1885, p. 258, pl. XVII. fig. 10.
? Amnicola nuttalliana Frauenfeld, Verh. der k. k. Zool.-bot. Ges. Wien., 1863, p. 1029.
Type locality: Lake Eustis, Fla.

Genus CLAPPIA Walker, 1909.

Clappia Walker, Naut., XXII, 1909, p. 89.
Type: *Clappia clappi* Walker.

CLAPPIA CLAPPI Walker.

Clappia clappi Walker, Naut., XXII, 1909, p. 89, pl. VI, figs. 1, 4 and 7.
Type locality: Coosa River, Duncan's Riffle, Chilton Co., Ala.

Subfamily LYOGYRINÆ Pilsbry, 1916.

Genus LYOGYRUS Gill, 1863.

LYOGYRUS BROWNII (Carpenter).

Amnicola brownii Carpenter, Central Falls (R. I.) Weekly Visitor, April, 1872.
Valvata (Lyogyrus) brownii Carpenter, Naut., III, 1889, p. 69.
Type locality: Cunliff's Pond, Elmville, R. I.

The citation of this species from Minnesota by Sargent (115, p. 126) is no doubt erroneous.

LYOGYRUS DALLI Pilsbry and Beecher.

Lyogyrus dalli Pilsbry and Beecher, Naut., VI, 1892, p. 62.
Type locality: Wekiva River, Fla.

LYOGYRUS GRANUM (Say).

Paludina grana Say, J. A. N. S. P., II, 1822, p. 378.
Amnicola granum W. G. Binney, L. and F. W. Shells, III, 1865, p. 86, fig. 170.

This species is known only from the Atlantic drainage in southeastern Pennsylvania and New Jersey. Western records for it and *L. brownii* are in all probability based upon some of the smaller species of *Amnicola*.

LYOGYRUS LEHNERTI Ancey.

Liogyrus lehnerti Ancey, Con. Ex., II, 1887, p. 79.
Type locality: Potomac River, Washington, D. C.

According to Pilsbry (87, p. 113) and part of the original lot in my collection, this is a reversed *Amnicola limosa* Say.

Genus HORATIA Bourguignat, 1887.

Horatia Bourguignat, Etude sur les noms gen. des petites Paludinidees &c., 1887, p. 47.

Westerlund (163, 4th Supp., p. 23) remarks that these small shells have the form of the smallest Pseudamnicolas, the structure of Lithoglyphus, the color of many Bythinellas and are allied to the Valvatas in their operculum. Typical *Horatia* is not represented in the North American fauna.

Subgenus HAUFFENIA Pollonera, 1898.

Hauffenia Pollonera, Boll. Mus. Zool. ed. Anat. Comp. Univ. Torino, XIII, 1898, p. 3.

HORATIA (HAUFFENIA) MICRA (Pilsbry and Ferriss).

Valvata micra Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 172, pl. IX, figs. 7-9.
Horatia (Hauffenia) micra Pilsbry, Naut., XXX, 1916, p. 83.
Type locality: Guadalupe River, New Braunfels, Texas.

HORATIA MICRA NUGAX (Pilsbry and Ferriss).

Valvata micra nugax Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 173, pl. IX, fig. 6.
Horatia (Hauffenia) micra nugax Pilsbry, Naut., XXX, 1916, p. 83.
Type locality: Guadalupe River, New Braunfels, Texas.

Subfamily POMATIOPSINÆ Stimpson, 1865.

Genus POMATIOPSIS Tryon, 1862.

POMATIOPSIS BINNEYI Tryon.

Pomatiopsis binneyi Tryon, Pr. A. N. S. P., 1863, p. 148, pl. I, fig. 10.
Bythinella binneyi W. G. Binney, L. and F. W. Shells, III, 1865, p. 69, figs. 136-137.
This species is a true *Pomatiopsis* according to Pilsbry (96, p. 123).

POMATIOPSIS CALIFORNICA Pilsbry.

Pomatiopsis californica Pilsbry, Naut., XII, 1899, p. 126.
Type locality: San Francisco, Cal.

POMATIOPSIS CINCINNATIENSIS (Lea).

Cyclostoma cincinnatiensis Lea, Pr. Am. Phil. Soc., I, 1840, p. 289.
Amnicola sayana "Anthony" Haldeman, Mon., 1844, p. 19, pl. I, fig. 11.

This species having proved to be a *Pomatiopsis,* Lea's name takes precedence over that of Anthony which was proposed on the supposition that the species was an *Amnicola.*

Baker (4, p. 343) has erroneously attributed the species to Anthony and his description, figures and synonymy are those of *Amnicola cincinnatiensis* Anth.

POMATIOPSIS HINKLEYI Pilsbry, Naut., X, 1896, p. 37.

Type locality: Black Falls, Florence, Ala.

POMATIOPSIS LAPIDARIA (Say).

Paludina lustrica Say, quoted as *Amnicola lustrica* by Haldeman and authors generally and as *Pomatiopsis lustrica* by Binney according to Pilsbry (89, p. 53) is the young of this species.

POMATIOPSIS ROBUSTA Walker.

Pomatiopsis robusta Walker, Naut., XXI, 1908, p. 97, text-fig.
Type locality: Jackson Lake, Wyo.

PLEUROCERIDÆ.

It has been suggested that the family name should be properly *Pleuroceratidæ*. But Stejneger (Herpetology of Japan, Bull. 58, U. S. Nat. Mus., p. 24) in a similar case has decided that the change is not necessary.

The errata given by Tryon on p. 427 of his "Strepomatidæ" are not included in his index and have, therefore, been noted under the several species as they are likely to be overlooked.

Pilsbry (Pilsbry and Rhoads, 111, p. 496) has proposed the following rearrangement of this family:

Genus IO Lea.

Type *Fusus fluvialis* Say.

Genus LITHASIA Haldeman.

Type *Anculosa* (*Lithasia*) *geniculata* Hald.

Section ANGITREMA Haldeman.

Type *Melania armigera* Say.

Genus PLEUROCERA Rafinesque.

Type ?

Section STREPHOBASIS Lea.

Types *S. spillmani, cornea* and *clarkii* Lea (all = *plena* Anth.)

Genus ELIMIA H. and A. Adams.

Type *Melania acutocarinata* Lea.

Genus GYROTOMA Shuttleworth.

Genus ANCULOSA Say.

Dr. Pilsbry has more recently decided that *Goniobasis* should be restored to its former position as a generic term, on the ground that *Elimia* was a composite group.

It will be noticed that no mention is made of *Eurycœlon* in this arrangement. While, as Tryon remarks (134, p. 341), the genus as aggregated by him is made up of incongruous elements and upon a revision of the family will no doubt be dismembered, the typical group, of which *anthonyi* and *crassa* are leading terms form a very distinct group, which seems entitled to recognition.

Genus LITHASIA Haldeman, 1840.

LITHASIA CURTA Lea.

Lithasia curta Lea, Pr. A. N. S. P., 1868, p. 153; Lea, Jour. A. N. S. P., VI, 1868, p. 340, pl. 54, fig. 24; Obs., XII, 1868, p. 100, pl. 54, fig. 24.

Type locality: Northern Alabama and Tuscumbia.

LITHASIA CYLINDRICA Lea.

Lithasia cylindrica Lea, Pr. A. N. S. P., 1866, p. 133; Jour. A. N. S. P., VI, 1868, p. 341, pl. 54, fig. 26; Obs., XII, 1868, p. 101, pl. 54, fig. 26.

Type locality: Coosa River, Ala.

LITHASIA OBOVATA (Say).

Pilsbry (101, p. 47) has figured the operculum of this species.

For an account of the early stages of growth in this species, see Walker, No. 143.

LITHASIA OBOVATA BICONICA Pilsbry.

Lithasia obovata biconica Pilsbry, 27th Ann. Rep. Dep't. Geol. & Nat. Resc. Ind., 1908, p. 604, fig. 23a.

Type locality: Wabash River, Gibson Co., Ind.

LITHASIA PLICATA Wetherby.

Lithasia plicata Wetherby, Jour. Soc. N. H. Cin., 1876, p. 9, pl. I, fig. 1.

Type locality: Green River, Jackson Co., Ky.

LITHASIA PURPUREA Lea.

Lithasia purpurea Lea, Pr. A. N. S. P., 1868, p. 153; Jour. A. N. S. P., VI, 1868, p. 340, pl. 54, fig. 23; Obs., XII, 1868, p. 100, pl. 54, fig. 23.

Type locality: Cahawba River, Centreville, Bibb Co., Ala.

LITHASIA WHEATLEYI Lea.

Lithasia wheatleyi Lea, Pr. A. N. S. P., 1866, p. 133; Jour. A. N. S. P., VI, 1868, p. 341, pl. 54, fig. 25; Obs., XII, 1868, p. 101, pl. 54, fig. 25.

Type locality: Cahawba River, Ala.

Section ANGITREMA Haldeman, 1841.

LITHASIA ANGULATA (Wetherby).

Angitrema angulata Wetherby, Jour. Cin. Soc. N. H., 1876, p. 11, pl. I, fig. 5.

Type locality: Stone's River, Rutherford Co., Tenn.

LITHASIA PARVA (Wetherby).

Angitrema parva Wetherby, Jour. Cin. Soc. N .H., 1876, p. 9, pl. I, fig. 2.

Type locality: Stone's River, Rutherford Co., Tenn.

PLEUROCERA Rafinesque, 1818.

Pilsbry (105, p. 114) from a consideration of the literature concludes that the type of *Pleurocera* Raf. is *verrucosa* Raf. and that it consequently takes the place of *Angitrema* Hald. and that for this group *Ceriphasia* Sw. should be used. This has been controverted by Walker, No. 161, who argues that the type of *Pleurocera* had never been properly designated and designates *P. acuta* Raf. as the type, thus retaining the name for the group with which it has commonly been known. In a similar case, Dall (29, p. 1141) had already taken the same position as advocated by Walker.

PLEUROCERA ACUTA Rafinesque.

Pleurocera acuta Rafinesque, Enumeration and Account, 1831, p. 3; Walker, Occ. Pap. Mus. Zool., U. of M., No. 38, p. 8.

Is identical with and has precedence over *P. subulare* Lea and is the type of *Pleurocera* Raf. It includes according to Goodrich (49, p. 122) *tractum* Anth., *neglectum* Anth., *intensum* Rve., *pallidum* Lea and *labiatum* Lea.

PLEUROCERA AFFINE (Lea).

Trypanostoma affine Lea, Obs., XI, 1866, p. 101, pl. 23, fig. 57.

PLEUROCERA ALTIPETUM (Anthony).

Trypanostoma corneum Lea, Obs., XI, 1866, p. 104, pl. 23, fig. 63.

PLEUROCERA ALVEARE (Conrad).

Includes *P. plicatum* Tryon.

PLEUROCERA ARATUM (Lea).

Trypanostoma cinctum Lea, Obs., XI, 1866, p. 103, pl. 23, fig. 60.

PLEUROCERA BICINCTUM Tryon.

Pleurocera bicinctum Tryon, Am. J. of Con., II, 1866, p. 4, pl. II, fig. 2.
Type locality: Bridgeport, Ala.

PLEUROCERA CARINATUM (Lea).

Trypanostoma carinatum Lea, Obs., XI, 1866, p. 104, pl. 23, fig. 62.

This species as suggested by Tryon is probably the young of some other species. If, however, it should prove to be a valid one, it will have to be renamed as *Pleurocera (Strephobasis) carinatum* Lea has priority.

PLEUROCERA CASTANEUM (Lea).

Trypanostoma castaneum Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 338, pl. 54, fig. 20; Obs., XII, 1868, p. 98, pl. 54, fig. 20.
Type locality: Coosa River, Ala.

PLEUROCERA CURRIERIANUM (Lea).

Trypanostoma currierianum Lea, Obs., XI, 1866, p. 103, pl. 23, fig. 61.

PLEUROCERA CYLINDRACEUM (Lea).

Trypanostoma cylindraceum Lea, Obs., XI, 1866, p. 98, pl. 23, fig. 51. Includes *P. roanense* Lea, according to Pilsbry (111, p. 498).

PLEUROCERA EXIMIUM (Anthony).

Has priority over *gradatum* (Anth.).

PLEUROCERA GLANDULUM (Anthony).

Is undoubtedly the young of one of the earlier described species of *Strephobasis* included in the synonymy of *plena*.

PLEUROCERA GRADATUM (Anthony).

Trypanostoma curtatum Lea, Jour. A. N. S. P., VI, 1866, p. 143, pl. 23, fig. 53; Obs., XI, 1866, p. 99, pl. 23, fig. 53.

PLEUROCERA LESLEYI (Lea).

Trypanostoma lesleyi Lea, Obs., XI, 1866, p. 102, pl. 23, fig. 59.

PLEUROCERA LEWISII (Lea).

As suspected by Tryon this form is only a striate variety of *elevatum*.

PLEUROCERA LYONII (Lea).

Trypanostoma lyonii Lea, Jour. A. N. S. P., VI, 1866, p. 144, pl. 23, fig. 55; Obs., XI, 1866, p. 100, pl. 23, fig. 55.

PLEUROCERA NAPOIDEUM (Lea).

Trypanostoma napoideum Lea, Obs., XI, 1866, p. 99, pl. 23, fig. 54.

PLEUROCERA NUCIFORME (Lea).

Trypanostoma nuciforme Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 337, pl. 54, fig. 19; Obs., XII, 1868, p. 97, pl. 54, fig. 19.

Type locality: Connesauga Creek, Whitfield Co., Ga.

PLEUROCERA PUMILUM (Lea).

Is probably the young of some other species. If valid however, it will have to be renamed as *Pleurocera* (*Stephobasis*) *pumilum* Lea has priority, unless that too should prove to be a synonym.

PLEUROCERA ROANENSE (Lea).

Trypanostoma roanense Lea, Obs., XI, 1866, p. 98, pl. 23, fig. 52.

PLEUROCERA SUBROBUSTUM (Lea).

Trypanostoma subrobustum Lea, Obs., XI, 1866, p. 97, pl. 23, fig. 50.

PLEUROCERA TEREBRALE (Lea).

Trypanostoma terebrale Lea, Pr. A. N. S. P., 1868, p. 153; Jour. A. N. S. P., VI, 339, pl. 54, fig. 22; Obs., XII, 1868, p. 99, pl. 54, fig. 22.
Type locality: Jackson Co., Ala.

PLEUROCERA UNDULATUM (Say).

Includes *M. excurata* Con. and *rorata* Rve., *T. moniliferum* Lea and *spillmani* Lea, and *Io nobilis* Lea, *nodosa* Lea, *robusta* Lea and *variabilis* Lea according to Pilsbry (111, p. 497).

PLEUROCERA UNIVITTATUM (Lea).

Trypanostoma univittatum Lea, Obs., XI, 1866, p. 101, pl. 23, fig. 58.

PLEUROCERA VENUSTUM (Lea).

Trypanostoma venustum Lea, Pr. A. N. S. P., 1864, p. 12; Jour. A. N. S. P., VI, 1866, p. 149, pl. 23, fig. 66; Obs., XI, 1866, p. 107, pl. 23, fig. 66.
Type locality: Big Prairie Creek, Ala.

PLEUROCERA WHEATLEYI (Lea).

Trypanostoma wheatleyi Lea, Pr. A. N. S. P., 1868, p. 153; Jour. A. N. S. P., VI, 1868, p. 338, pl. 54, fig. 21; Obs., XII, 1868, p. 99, pl. 54, fig. 21.
Type locality: Coosa River, Ala.

Section STREPHOBASIS Lea, 1861.

PLEUROCERA CURTUM (Haldeman).

Dr. James Lewis (68, p. 224) suggested a long synonymy for this species, "not as being conclusive, but as being in many particulars deserving of inquiry". Tryon (133, p. 88) in a review of Lewis' paper, states that upon the invitation of Dr. Lea, he had re-examined the types of the species included in the proposed synonymy, which resulted in a renewed assurance that his original determinations respecting them were correct. Later, (Tryon, 134, p. 424) Lewis states that on reviewing the matter, he had ascertained "that one of Say's species (hitherto treated as superfluous) was really entitled to take precedence of *curtum*".

PLEUROCERA BITÆNIATUM (Conrad).

According to Pilsbry (111, p. 499) *Strephobasis clarkii* Lea is not a synonym of this species, but of *plena* Anth.

PLEUROCERA LYONII (Lea).

Strephobasis lyonii Lea, Jour. A. N. S. P., VI, 1866, p. 151, pl. 23, fig. 65; Obs., XI, 1866, p. 107, pl. 23, fig. 65.

The figure given by Tryon (134, p. 46, fig. 93) for this species is erroneous and is that of *Eurycœlon umbonatum* (loc. cit. fig. 658).

If *Pleurocera (Trypanostoma) lyonii Lea* is a valid species, it has priority over this one, which, if also a valid species, will have to have a new name. But in the present chaotic state of our knowledge of the family, it does not seem advisable to propose one until the double question of synonymy is definitely settled.

PEUROCERA PLENUM (Anthony).

Includes *clarkii* (Lea), *corneum* (Lea) and *spillmani* (Lea) according to Pilsbry (111, p. 499) and *P. glandulum* (Anth.).

"STREPHOBASIS" HARTMANIANA Lea MSS.

Is listed by Lewis (l. c.) among the probable synonyms of *P. curtum* (Hald.). It does not appear to have ever been described.

Genus GONIOBASIS Lea, 1862.

Hannibal (53, p. 179) has designated *G. osculata* Lea as the generic type.

GONIOBASIS ACUTIFILOSA (Stearns).

Melania (? Goniobasis) acutifilosa Stearns, Pr. U. S. Nat. Mus., XIII, 1890, p. 211, pl. XV, fig. 9.

Type locality: Eagle Lake, Cal.

GONIOBASIS ACUTIFILOSA SISKIYOUENSIS Pilsbry.

Goniobasis acutifilosa siskiyouensis Pilsbry, Naut., XIII, 1899, p. 65.

Type locality: Fall River, Siskiyou Co., Cal.

GONIOBASIS ALBANYENSIS Lea.

Goniobasis albanyensis Lea, Pr. A. N. S. P., 1864, p. 4; Jour. A. N. S. P., VI, 1866, p. 140, pl. 23, fig. 49; Obs., XI, 1866, p. 97, pl. 23, fig. 49.

Type locality: Albany and Blue Spring, Baker Co., Ga.

GONIOBASIS ARACHNOIDEA (Anthony).

Includes *baculum* Anth. according to Lewis (69, p. 114).

GONIOBASIS ARATA Lea.

Goniobasis arata Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868, p. 329, pl. 54, fig. 4; Obs., XII, 1868, p. 89, pl. 54, fig. 4.
Type locality: Connesauga Creek, Whitfield Co., Ga.

GONIOBASIS ATERINA Lea.

Goniobasis aterina Lea, Jour. A. N. S. P., VI, 1866, p. 136, pl. 23, fig. 42; Obs., XI, 1866, p. 92, pl. 23, fig. 42.

GONIOBASIS BACULOIDES Lea.

Goniobasis baculoides Lea, Pr. A. N. S. P., 1869, p. 125; Jour. A. N. S. P., VIII, 1874, p. 62, pl. 21, fig. 18; Obs., XIII, 1874, p. 66, pl. 21, fig. 18.
Type locality: Coosa River, Ala.

GONIOBASIS BIFASCIATA Lea.

Goniobasis bifasciata Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868, p. 331, pl. 54, fig. 7; Obs., XII, 1868, p. 91, pl. 54, fig. 7.
Type locality: Jackson Co., Ala.

GONIOBASIS BOYKINIANA (Lea).

Includes *hallenbeckii* Lea according to Pilsbry (90, p. 124). See also *catenaria*.

GONIOBASIS BULBOSA (Gould).

Includes *newberryi* Lea according to Pilsbry (95, p. 66).

GONIOBASIS CALIFORNICA (Clessin).

Melania californica Clessin, Mal. Blætt., V, 1882, p. 189, pl. 4, figs. 9-9.
Type locality: California.
See *nigrina*.

GONIOBASIS CATENARIA (Say).

Includes *G. sublirata* (Con.), *floridensis* (Rve.), *etowahensis* (Lea), *papillosa* (Anth.), and *downieiana* Lea and probably also *boykiniana* (Lea), *hallenbeckii* Lea, *bentonensis* Lea and *couperi* Lea, according to Pilsbry (90, p. 124).

GONIOBASIS CINGENDA Anthony.

Goniobasis cingenda Anthony, Am. J. Con., II, 1866, p. 146, pl. 7, fig. 3.
Type locality: North Carolina.

GONIOBASIS CIRCUMLINEATA Tryon.

Goniobasis circumlineata Tryon, Am. J. of Con., II, 1865, p. 244, pl. 24, figs. 14-15.

Type localities: Mission San Antonio, Shasta Co.; Pit River and Feather River, Cal.

Probably only a variety of *G. nigrina* according to Pilsbry (95, p. 66).

GONIOBASIS CLATHRATA Lea.

Goniobasis clathrata Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868, p. 331, pl. 54, fig. 8; Obs., XII, 1868, p. 91, pl. 54, fig. 8.

Type locality: Jackson Co., Ala.

GONIOBASIS CLAVULA Lea.

Goniobasis clavula Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 335, pl. 54, fig. 15; Obs., XII, 1868, p. 95, pl. 54, fig. 15.

Type locality: Jackson Co., Ala.

GONIOBASIS COCHLIARIS Lea.

Goniobasis cochliaris Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 336, pl. 54, fig. 16; Obs., XII, 1868, p. 96, pl. 54, fig. 16.

Type locality: Shelby Co., Ala.

GONIOBASIS COLUMBIENSIS Whiteaves.

Goniobasis columbiensis Whiteaves, Naut., XIX, 1905, p. 61, pl. II, figs. 11-12.

Type locality: Upper Columbia River, B. C.

This is probably only a form of *livescens.*

GONIOBASIS COMALENSIS Pilsbry.

Goniobasis pleuristriatus comalensis Pilsbry, Naut., IV, 1890, p. 49.

Goniobasis comalensis Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 167, fig. 24-31.

Type locality: Comal Creek, New Braunfels, Texas.

Melania pluristriata Say is a *Pachycheilus* and is not found in Texas. All the Texan records of that species refer to *comalensis.*

The var. *marmocki* mentioned, but not described by Wetherby (Am. Nat. XII, 1868, p. 254) seems to have been abandoned by him. His shells came from Helotes, Bexar Co., Texas and the set of *"pleuristriata"* in his collection, now in my possession, includes both the striate and smooth forms. There are none labelled var. *marmocki.*

GONIOBASIS COMALENSIS FONTINALIS Pilsbry and Ferriss.

Goniobasis comalensis fontinalis Pilsbry and Ferriss, Pr. A. N. S. P., 1906, p. 168, figs. 32-35.
Type locality: Spring, New Braunfels, Texas.

GONIOBASIS CONNESAUGAENSIS Lea.

Goniobasis connesaugaensis Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 333, pl. 54, fig. 11; Obs., XII, 1868, p. 93, pl. 54, fig. 11.
Type locality: Connesauga Creek, Whitfield Co., Ga.

GONIOBASIS CONTIGUA Lea.

Goniobasis contigua Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 334, pl. 54, fig. 12; Obs., XII, 1868, p. 94, pl. 54, fig. 12.
Type locality: Connesauga Creek, Whitfield Co., Ga.

GONIOBASIS CRANDALLI Pilsbry.

Goniobasis crandalli Pilsbry, Pr. A. N. S. P., 1890, p. 301, pl. V, fig. 4-5.
Type locality: Mammoth Spring, Ark.

GONIOBASIS CUMBERLANDENSIS Lea.

Goniobasis cumberlandensis Lea, Pr. A. N. S. P., 1863, p. 155; Jour. A. N. S. P., VI, 1866, p. 132, pl. 23, fig. 35; Obs., XI, 1866, p. 88, pl. 23, fig. 35.

Tryon (134, p. 272) considers this a synonym of *G. adusta* (Anth.), and erroneously quotes it as *G. cumberlandiensis*

GONIOBASIS DECAMPII Lea.

Goniobasis decampii Lea, Jour. A. N. S. P., VI, 1866, p. 138, pl. 23, fig. 45; Obs., XI, 1866, p. 94, pl. 23, fig. 45.

GONIOBASIS DEPYGIS (Say).

Is considered a variety of *livescens* by Baker (4, p. 327) and Sterki (124A, p. 385), but is distinct.

GONIOBASIS EMERYENSIS Lea.

Goniobasis emeryensis Lea, Pr. A. N. S. P., 1864, p. 3; Jour. A. N. S. P., VI, 1866, p. 127, pl. 23, fig. 43; Obs., XI, 1866, p. 93, pl. 23, fig. 43.
Type locality: Rocky Creek, Head Branch of Emery River, Tenn.

GONIOBASIS FRATERNA Lea.

Goniobasis fraterna Lea, Pr. A. N. S. P., 1864, p. 111; Jour. A. N. S. P., VI, 1866, p. 139, pl. 23, fig. 46; Obs., XI, 1866, p. 95, pl. 23, fig. 46.
Type locality: Bibb Co. and Cahawba River, Ala.

GONIOBASIS GESNERI Lea.

Goniobasis gesneri Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868 p. 330, pl. 54, fig. 5; Obs., XII, 1868, p. 90, pl. 54, fig. 5.
Type locality: Uchee River, Ala.

GONIOBASIS GOULDIANA Lea.

Goniobasis pulchella Lea, Pr. A. N. S. P., 1868, p. 151, *non pulchella* Anth. (1850).
Goniobasis gouldiana Lea, Jour. A. N. S. P., VI, 1868, p. 332, pl. 54, fig. 9; Obs., XII, 1868, p. 92, pl. 54, fig. 9.
Type locality: North Alabama.

GONIOBASIS GRANATOIDES Lea.

Goniobasis granatoides Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 335, pl. 54, fig. 14; Obs., XII, 1868, p. 95, pl. 54, fig. 14.
Type locality: Connesauga Creek, Whitfield Co., Ga.

GONIOBASIS INDIANENSIS Pilsbry.

Goniobasis indianensis Pilsbry, 27th Ann. Rep. Dep't. Geol. and Nat. Res. Ind., 1903, p. 606, fig. 28.
Type locality: Blue River, Wyandotte, Crawford Co., Ind.

GONIOBASIS LÆVIGATA (Lea).

This species, if a valid one, will have to be called *leaii* Brot as *Melania lævigata* is preoccupied by Lamarck.

GONIOBASIS LAQUEATA (Say).

Includes *deshayesiana* (Lea) and "probably" also *cerea, corrugata, costulata, cinerella, circincta, lyonii, plicatula, rugosa* and *sparus,* all of Lea and *athleta* and *glauca* of Anthony according to Pilsbry (111, p. 499).

GONIOBASIS LAWRENCEI Lea.

Goniobasis lawrencei Lea, Pr. A. N. S. P., 1869, p. 125; Jour. A. N. S. P., VIII, 1874, p. 62, pl. 21, fig. 17; Obs., XIII, 1874, p. 66, pl. 21, fig. 17.
Type locality: Washita River, Hot Springs, Ark.

GONIOBASIS LUTEOCELLA Lea.

Goniobasis luteocella Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868, p. 332, pl. 54, fig. 10; Obs., XII, 1868, p. 92, pl. 54, fig. 10.
Type locality: Connesauga Creek, Whitfield Co., Ga. and Oconee River.

GONIOBASIS MILESII Lea.

Goniobasis milesii Lea, Jour. A. N. S. P., VI, 1866, p. 135, pl. 23, fig. 40; Obs., XI, 1866, p. 90, pl. 23, fig. 40.

GONIOBASIS MURRAYENSIS Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 334, pl. 54, fig. 13; Obs., XII, 1868, p. 92, pl. 54, fig. 13.

Type locality: Swamp Creek, Whitfield Co., Ga.

GONIOBASIS NIGRINA Lea.

Includes *californica* (Cless.) and *draytonii* Lea and perhaps should be included in *bulbosa* (Gld.) according to Pilsbry (95, p. 66).

GONIOBASIS ORNATA Lea.

Goniobasis ornata Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 337, pl. 54, fig. 18; Obs., XII, 1868, p. 97, pl. 54, fig. 18.
Type locality: Connesauga Creek, Whitfield Co., Ga.

GONIOBASIS OSCULATA Lea.

Erroneously printed as *"inosculata"* by Tryon (134, p. 302) but corrected in the errata. Is the type by designation of *Goniobasis* Lea.

GONIOBASIS OZARKENSIS Call.

Goniobasis ozarkensis Call, Bull. Washburne Coll., I, 1886, p. 189, pl. 7, fig. 1-10.
Type locality: Blue Spring, Shannon Co., Mo.

GONIOBASIS PENNSYLVANICA Pilsbry.

Goniobasis pennsylvanica Pilsbry, Naut., XXX, 1916, p. 4.
Type locality: Ohio River, Coraopolis, Pa.

GONIOBASIS PLEBEIUS Anthony.

Is a valid species and includes *cubicoides* (Anth.) according to Pilsbry (97, p. 458).

GONIOBASIS PLICATA-STRIATA Wetherby.

Goniobasis plicata-striata Wetherby, Jour. Cin. Soc. Nat. Hist., 1876, p. 10, pl. I, fig. 3.

Type locality: Stone River and Mill Creek, Rutherford Co. and Sinking Creek, Shelbyville, Tenn.

GONIOBASIS PLICIFERA Lea.

Includes *silicula* (Gld.), *rudens* (Rve.), *bairdiana* Lea and *shastensis* (Lea) according to Pilsbry (95, p. 66).

GONIOBASIS PLICIFERA BULIMOIDES Tryon.

Goniobasis plicifera bulimoides Tryon, Am. J. of Con., I., 1865, p. 238, pl. 24, figs. 5-6.

Type locality: Wahlamat River, Ore.

GONIOBASIS PLICIFERA OREGONENSIS Tryon.

Goniobasis plicifera oregonensis Tryon, Am. J. of Con., I., 1865, p. 238, pl. 24, fig. 4.

Type locality not specified.

GONIOBASIS PORRECTA Lea.

Goniobasis porrecta Lea, Jour. A. N. S. P., VI, 1866, p. 139, pl. 23, fig. 47; Obs., XI, 1866, p. 25, pl. 23, fig. 47.

GONIOBASIS PROXIMA (Say).

Includes *symmetrica* as a variety according to Pilsbry (111, p. 499).

Reeve in his errata states that the shell figured by him (Fig. 275) as this species does not represent it according to Anthony. The figure is not cited by Tryon and has not, apparently, been identified.

GONIOBASIS PULLA Lea.

Goniobasis pulla Lea, Pr. A. N. S. P., 1864, p. 112; Jour. A. N. S. P., VI, 1866, p. 130, pl. 23, fig. 32; Obs., XI, 1866, p. 86, pl. 23, fig. 32.

Type locality: Cumberland Gap, Tenn.

GONIOBASIS PUPÆFORMIS Lea.

Goniobasis pupæformis Lea, Pr. A. N. S. P., 1864, p. 112; Jour. A. N. S. P., VI, 1866, p. 130, pl. 23, fig. 31; Obs., XI, 1866, p. 86, pl. 23, fig. 31.

Type locality: Coosa River, Ala.

GONIOBASIS ROMÆ Lea.

Goniobasis romæ Lea, Pr. A. N. S. P., 1864, p. 111; Jour. A. N. S. P., VI, 1866, p. 129, pl. 23, fig. 30; Obs., XI, 1866, p. 85, pl. 23, fig. 30.
Type locality: Rome, Ga.

GONIOBASIS RUFESCENS (Lea).

Reeve in his errata states that he had been informed by Anthony that the shell figured by him as this species (Fig. 279) does not represent the species. This figure is not cited by Tryon and, apparently, has not been identified.

GONIOBASIS SIMILIS Lea.

Goniobasis similis Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868, p. 328, pl. 54, fig. 2; Obs., XII, 1868, p. 88, pl. 54, fig. 2.
Type locality: Connesauga Creek, Whitfield Co., Ga.

GONIOBASIS SMITHSONIANA Lea.

Goniobasis smithsoniana Lea, Pr. A. N. S. P., 1864, p. 112; Jour., A. N. S. P., VI, 1866, p. 137, pl. 23, fig. 44; Obs., XI, 1866, p. 93, pl. 23, fig. 44.
Type locality: North Georgia and East Tennessee.

GONIOBASIS STEARNSIANA Call.

Goniobasis stearnsiana Call, Pr. Davenport Acad. Nat. Sci., V, 1886, p. 6, fig. 43.
Type locality: Dyke's Creek, Floyd Co., Ga.

GONIOBASIS SUBRHOMBICA Lea.

Goniobasis subrhombica Lea, Pr. A. N. S. P., 1864, p. 111; Jour. A. N. S. P., VI, 1866, p. 132, pl. 23, fig. 34; Obs., XI, 1866, p. 88, pl. 23, fig. 34.
Type locality: Hog Creek, North Georgia.

GONIOBASIS SULCATA Lea.

Goniobasis sulcata Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868, p. 329, pl. 54, fig. 3; Obs., XII, 1868, p. 89, pl. 54, fig. 3.
Type locality: Cahawba River, Ala.

GONIOBASIS UNDULATA Tryon.

Goniobasis undulata Tryon, Am. J. of Con., II, 1866, pl. II, fig. 4.
Type locality: Georgia.

GONIOBASIS VENUSTA Lea.

Goniobasis venusta Lea, Pr. A. N. S. P., 1868, p. 152; Jour. A. N. S. P., VI, 1868, p. 336, pl. 54, fig. 17; Obs., XII, 1868, p. 96, pl. 54, fig. 17.
Type locality: Coosa River, Ala.

GONIOBASIS VERSA Lea.

Melania blanda Lea, Pr. A. N. S. P., 1861, p. 122, *non blanda* Lea (1841).
Goniobasis blanda Lea, Jour. A. N. S. P., V, 1863, p. 242, pl. 35, fig. 44; Obs., IX, 1863, p. 64, pl. 35, fig. 44.
Goniobasis versa Lea, Jour. A. N. S. P., VI, 1866, p. 127; Obs., XI, 1867, p. 93.
Goniobasis leai Tryon, L. and F. W. Shells, Pt. IV, 1873, p. 163, *non* Brot (1862-8).
Type locality: Yellowleaf Creek, Ala.

GONIOBASIS VIRGINICA Gmelin.

Add to the synonymy, *Gon. virginica bilirata* De Gregorio (35, p. 39).

GONIOBASIS VIRIDISTRIATA Lea.

Goniobasis viridistriata Lea, Pr. A. N. S. P., 1864, p. 4; Jour. A. N. S. P., VI, 1866, p. 140, pl. 23, fig. 48; Obs., XI, 1866, p. 96, pl. 23, fig. 48.
Type locality: Flint River, Ga.

GONIOBASIS WHEATLEYI Lea.

Goniobasis wheatleyi Lea, Pr. A. N. S. P., 1868, p. 151; Jour. A. N. S. P., VI, 1868, p. 328, pl. 54, fig. 1; Obs., XII, 1868, p. 88, pl. 54, fig. 1.
Type locality: Coosa River, Ala.

GONIOBASIS WHITFIELDENSIS Lea.

Goniobasis tenebrosa Lea, Pr. A. N. S. P., 1868, p. 151, *non Mel. tenebrosa* Lea (1841).
Goniobasis whitfieldensis Lea, Jour. A. N. S. P., VI, 1868, p. 330, pl. 54, fig. 6; Obs., XII, 1868, p. 90, pl. 54, fig. 6.
Type locality: Connesauga Creek, Whitfield Co., Ga.

Genus GYROTOMA Shuttleworth, 1845.

Schizostoma Lea (1842), *non* Brown (1835).

GYROTOMA LEWISII (Lea).

Schizotoma lewisii Lea, Pr. A. N. S. P., 1869, p. 125; Jour. A. N. S. P., VIII, 1874, p. 61, pl. 21, fig. 16; Obs., XIII, 1874, p. 65, pl. 21, fig. 16.
Type locality: Coosa River, Ala.

GYROTOMA SHOWALTERI (Lea).

Schizostoma showalteri Lea, Pr. A. N. S. P., 1864, p. 112; Jour. A. N. S. P., VI, 1866, p. 149, pl. 23, fig. 56; Obs., XI, 1866, p. 105, pl. 23, 56.

This is a different species from that described by Lea under the same name in 1860, which proved to be a synonym of *G. cariniferum* (Anth). The name being preoccupied, this species will have to be re-named, if it should prove to be a valid one on a revision of the genus.

GYROTOMA WHEATLEYI (Lea).

Schizostoma wheatleyi Lea, Pr. A. N. S. P., 1868, p. 153; Jour. A. N. S. P., VI, 1868, p. 342, pl. 54, fig. 27; Obs., XII, 1868, p. 102, pl. 54, fig. 27.

Type locality: Coosa River, Ala.

Genus ANCULOSA Say, 1821.

Pilsbry has recently come to the conclusion (105, p. 109) that *Leptoxis* Raf. should be preferred for this genus. In my paper on *Pleurocera* (161, p. 1) I reluctantly acquiesced in his conclusion on the ground that the question was zoological rather than one of Code construction. Since that time I have again gone carefully over the ground and have become satisfied that, if all incompetent evidence is eliminated, there is not sufficient grounds to justify the change. I have therefore retained Say's well known name for the genus.

ANCULOSA ARKANSENSIS Hinkley.

Anculosa arkansensis Hinkley, Pr. U. S. Nat. Mus., 49, 1915, p. 587, pl. 78, fig. 3.

Type locality: North Fork of White River, above Norfolk, Ark.

ANCULOSA DOWNIEI Lea.

Anculosa downiei Lea, Pr. A. N. S. P., 1868, p. 153; Jour. A. N. S. P., VI, 1868, p. 342, pl. 54, fig. 28; Obs., XII, 1868, p. 102, pl. 54, fig. 28.

Type locality: Connesauga Creek, Whitfield Co., Ga. and Coosa River, Ala.

ANCULOSA HARPETHENSIS Pilsbry.

Anculosa harpethensis Pilsbry, Pr. A. N. S. P., 1896, p. 499.

Type locality: Big Harpeth River, Bellevue, Tenn.

ANCULOSA MINOR Hinkley.

Anculosa minor Hinkley, Naut., XXVI, 1912, p. 47, pl. I, figs. 7-8.

Type locality: Tennessee River, Florence, Ala.

ANCULOSA SUBGLOBOSA Say.

Does not include *A. tintinnabulum* Lea and *virgata* Lea as stated by Tryon (134, p. 404). See Walker (150, p. 110).

ANCULOSA TINTINNABULUM Lea.

Is a valid species and does not include *virgata* Lea. See Walker (l. c.).

ANCULOSA TRYONI Lewis.

Anculosa tryoni Lewis, Am. J. of Con., VI, 1870, p. 221, pl. 12, fig. 8.
Type locality: Holston River, Tenn.

Tryon (133, p. 87) considers this to be the *tæniata* Con., but the approximation is at the best very doubtful.

ANCULOSA UMBILICATA Wetherby.

Anculosa umbilicata Wetherby, Jour. Cin. Soc. Nat. Hist., 1876, p. 11, pl. I, fig. 4.
Type locality: Stone River, Rutherford Co., Tenn.

ANCULOSA VIRGATA Lea.

Is not the young of *tintinnabulum* as stated by Tryon (134, p. 404), but is a valid species. See Walker (150, p. 110).

Genus MESECHIZA Lea.

Has no standing. The type species is the young of *Angitrema verrucosa*. See Hinkley (57, p. 56).

Family NERITIDÆ.

Genus NERITINA Lamarck, 1809.

NERITINA RECLIVATA Say.

v. Martens (73, p. 472) considers that this is only a variety of *N. lineolata* Lam.

NERITINA RECLIVATA PALMÆ Dall.

Neritina reclivata palmæ Dall, Pr. U. S. Nat. Mus., 1885, p. 259.
Type locality: Palma Sola, Fla.

Genus LEPYRIUM Dall, 1896.

Lepyrium Dall, Naut., X, 1896, p. 15.
Type: *Neritina showalteri* Lea.

LEPYRIUM SHOWALTERI CAHAWBENSIS Pilsbry.

Lepyrium showalteri cahawbensis Pilsbry, Naut., XX, 1906, p. 51.
Type locality: Cahawba River, Ala.

Class LAMELLIBRANCHIA.

Order EULAMELLIBRANCHIA.

Suborder SUBMYTILACEA.

Family MARGARITANIDÆ.

Ortmann (79, p. 223) has raised the genus *Margaritana* to the rank of a family and (80, p. 13) has proposed a new genus, *Cumberlandia,* for *M. monodonta* (Say), both based upon anatomical peculiarities

For the distribution of the genus in this country, see Walker, Nos. 152 and 153, Ortmann (80, p. 14) and Utterback (135, p. 99).

MARGARITANA MARGARITIFERA (L.).

Unio ocmulgeensis dominus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 13, pl. 7, fig. a-c.

Family UNIONIDÆ.

Simpson's "Descriptive Catalogue of the Naiades" brings the subject down to January 1, 1913.

For the revised classification so far as it has progressed, see Part I.

In view of the relatively small number of species that have been examined anatomically and the consequent element of uncertainty as to the systematic position of the remainder that must continue until the animals can be critically examined, it has seemed better, for convenience of reference, in this porton of the work to retain the generic names given by Simpson, noting, however, under such species as have been examined anatomically their proper place in the revised classification.

Recent attempts to revive Rafinesque's names for many of the species have created considerable confusion as to the proper nomenclature to be followed.

Vanatta's valuable paper on "Rafinesque's Types of Unio" (140, p. 549), reviewed by Walker (158, p. 43), has given definite information as to what Rafinesque in 1831 understood or claimed to be the species that he had described in 1820.

It has been too hastily assumed by some that these determinations have definitely settled the validity of all of the Rafinesqueian species involved. This is far from correct. It is not claimed, except in one instance, that the so-called types in the Poulson collection are the original types of Rafinesque. And, even if they were, reference to them for the purpose of determining an otherwise unidentifiable description is prohibited by the International Code (Op. Int. Co., I). The requisites for a sufficient description are definitely specified by the Code (Art. 25) and these provisions as defined by the decisions of the International Committee must be applied to each individual case.

Dr. Pilsbry in Vanatta's paper has very aptly stated the situation as follows: "The use of a Rafinesquian name depends upon whether it could be identified by descriptions published prior to any other recognizable name for the same species. That it can be recognized from the types or other specimens from Rafinesque does not entitle his names to acceptance unless the published descriptions are adequate. This question of the adequacy of published diagnoses must be considered for each species separately."

In the same connection, see Walker, (157, p. 74).

Subfamily UNIONINÆ (Swainson, 1840), Ortmann, 1910.

Genus QUADRULA Rafinesque, 1820.

QUADRULA ASKEWI (Marsh).

Frierson (41, p. 136) refers this to *beadleiana* Lea. But Ortmann (81, p. 21) states that it does not group with that species, but is a *Fusconaia* of the *undata* group.

QUADRULA BEADLEIANA (Lea).

Includes *Q. chickasawhensis* (Lea) and *askewi* (Marsh) according to Frierson (41, p. 136). But Ortmann (79, p. 268) says that it is an *Elliptio*.

QUADRULA BURSAPASTORIS (B. H. Wright).

Is a *Fusconaia* according to Ortmann (81, p. 90).

QUADRULA COCCINEA (Conrad).

Is a *Pleurobema* according to Ortmann (77, p. 101) and a variety of *Q. obliqua* (Lam.) (78, p. 117 and 79, p. 263).

Utterback (135, p. 190) quotes *catillus* Con., which Simpson has considered a synonym of *Q. coccinea*, as a variety of *Q. obliqua* (Lam.) and on p. 193 of the same paper considers it identical with *Q. solida* (Lea), having priority and gives it specific rank as such.

QUADRULA COOPERIANA (Lea).

At first referred to *Pleurobema* by Ortmann (78, p. 117), this species is now included in *Plethobasus* by him (79, p. 261).

QUADRULA CYLINDRICA (Say).

Unio cylindricus propetypicus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 11, pl. 4, fig. 1.

Unio cylindricus acrispatus De Gregorio, Ibid, p. 11, pl. 4, fig. 2.

Vanatta (140, p. 556) states that the *Unio solenoides* Raf. of the Poulson collection is this species.

Quadrula ebenus (Lea).

Is *Obovaria obovalis* Raf. of the Poulson collection according to Vanatta (140, p. 558). If identifiable from the original description, *obovalis* would have precedence.

Quadrula frierson (B. H. Wright).

Is a *Pleurobema* according to Ortmann (81, p. 30).

Quadrula heros (Say).

This species is the type of *Megalonaias* Utterback.

Frierson (45, p. 61) has identified Barnes' *Unio giganteus* as this species and gives it priority.

Quadrula intermedia (Conrad).

Unio tuberosus perlobatus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 9, pl. I, fig. 3.

Quadrula kirtlandiana (Lea).

Is a variety of *Q. subrotunda* (Lea) according to Ortmann (78 p. 116).

Quadrula lachrymosa (Lea).

This species has been identified as the *Obliquaria quadrula* Raf. by Say, Conrad and others and Vanatta (140, p. 556) states that the shell so labelled in the Poulson collection is Lea's *asperrimus*. If identifiable from the original description, it would have priority.

Quadrula lachrymosa contraryensis Utterback.

Quadrula lachrymosa contraryensis Utterback, Amer. Mid. Nat., IV, 1915, p. 138, pl. XVIII, figs. 47a-b.

Type locality: Lake Contrary, St. Joseph, Mo.

Pleurobema missouriensis (Marsh).

The type of this species has been figured by Walker (155, p. 140, pl. V, figs. 1-2) and it appears to be a *Quadrula* allied to *Q. subrotunda* (Lea).

Quadrula obliqua (Lam.).

Includes *pyramidata* Lea, *cocinea* Con., and *plena* Lea according to Ortmann (78, p. 117 and 79, p. 264) and is a *Pleurobema*. Vanatta states (140, p. 557) that the *Obliquaria lateralis* Raf. of the Poulson collection is this species.

QUADRULA PERUVIANA (Lamarck).

Lamarck in his original description refers to the figure in the Encyc. Meth., pl. 248, fig. 7, but the reference was overlooked by Simpson in his Synopsis, but was supplied in the Desc. Catalogue. The species is the form commonly called *plicata* Say by collectors and is characterized by its prominent beaks. It is quite different from *plicata* Say from Lake Erie.

QUADRULA RARIPLICATA (Lamarck).

This species, which has been referred to *plicata* Say by Simpson and authors generally, is neither typical *peruviana* (Lam.) nor typical *plicata* (Say). The type which is still preserved in the Museum at Geneva, Switzerland, is the Ohio River form, which has commonly passed as *plicata* (Say), and is sufficiently distinct to have varietal rank at least. There is some reason to believe that Say's *plicata* is an off-shoot from this race rather than of *undulata* Bar. as has been suggested by Ortmann (79, p. 246). It is also possible that it rather than *undulata* should be considered the *costata* Raf.

QUADRULA PLICATA (Say).

As stated by Ortmann (79, p. 246) the type of this species came from Lake Erie and is undoubtedly the form described by Lea as *Unio hippopæus*. It has been referred to *undulata* Bar. by Ortmann (l. c.), but there is apparently some ground for considering it as more closely allied to *rariplicata* (Lam.). Pending the settlement of this question, it would seem better to keep it separate from either.

QUADRULA PLENA (Lea).

According to Ortmann (78, p. 117) this is probably only a form of *obliqua* (Lam.). Vanatta states (140, p. 558) that the *Obovaria cordata* Raf. of the Poulson collection is this species. If identifiable from the original description, Rafinesque's name would have priority.

QUADRULA PUSTULATA (Lea).

According to Vanatta (140, p. 557) the *Obliquaria nodulata* Raf. of the Poulson collection is this species. If identifiable from the original description, *nodulata* would have precedence.

QUADRULA PUSTULOSA (Lea).

According to Vanatta (140, p. 556) the *Obliquaria retusa* Raf. of the Poulson collection is "probably" this species. The specific name is not preoccupied by *Unio retusa* Lam. and, if identifiable from the original description, Rafinesque's name would have priority.

Utterback (135, p. 131) has suggested that the species should be known as *bullata* Raf., but see next note.

Quadrula pustulosa pernodosa (Lea).

According to Vanatta (140, p. 557) the *Obliquaria bullata* Raf. of the Poulson collection is this form, but the name is preoccupied by *Obliquaria flexuosa bullata* Raf. and Lea's name will stand.

Quadrula pyramidata (Lea).

Unio plenus interduos De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 18.

According to Ortmann this is probably only a form of *obliqua* (Lam.). Vanatta states (140, p. 557) that the *Obliquaria rubra* Raf. of the Poulson collection is this species. If identifiable from the original description, *rubra* would have priority.

Quadrula refulgens (Lea).

Includes *sphærica* (Lea) according to Frierson (41 p. 136).

Quadrula rubiginosa (Lea).

Unio validus continuus De Gregorio, Moll. di aq. di Amer., 1914, p. 21.

This species has been identified as the *Obliquaria flava* Raf. by Say, Conrad and others. According to Vanatta (140, p. 557) the *O. flava* Raf. of the Poulson collection is this species. If identifiable from the original description, Rafinesque's name would have priority.

According to Ortmann (78, p. 116) *rubiginosa* is a variety of *undata* (Bar.).

Fusconaia selecta Wheeler.

Fusconaia selecta Wheeler, Naut., XXVIII, 1914, p. 76, pl. IV.
Type locality: Cache River, Nemo, Craighead Co., Ark.

Quadrula sphærica (Lea).

Is a synonym of *refulgens* (Lea) according to Frierson (41, p. 136).

Quadrula subrotunda (Lea.)

According to Vanatta (140, p. 558) the *Obliquaria sintoxia* Raf. of the Poulson collection is this species. If identifiable from the original description, *sintoxia* would have precedence. The species is a *Fusconaia* according to Ortmann (79, p. 244).

Fusconaia subrotunda leucogone Ortmann.

Fusconaia subrotunda leucogone Ortmann, Naut., XXVII, p. 89.
Type locality: Elk River, Gassaway, Braxton Co., W. Va.

QUADRULA TRAPEZOIDES (Lea).

Bariosta ponderosus Raf. is a synonym and *Bariosta* Raf. is a synonym of *Amblema* Raf., unless the species should prove to be generically distinct according to Frierson (42, p. 7).

FUSCONAIA UNDATA TRIGONOIDES "Frierson" Utterback.

Fusconaia undata trigonoides "Frierson" Utterback, Amer. Mid. Nat., IV, 1915, p. 107, pl. XV, figs. 30A-D.

Type locality: Platte River, Agency Ford, Mo.

QUADRULA UNDULATA (Barnes).

This species has been identified as the *Amblema costata* Raf. by Conrad, Frierson and others. Vanatta states (140, p. 556) that the *Amblema costata* Raf. of the Poulson collection is also this species. If identifiable from the original description, Rafinesque's name would have priority. In considering this question attention should be given to the possibility that *costata* Raf. may be the *rariplicata* Lam.

Costata has been designated by Frierson (42, p. 7) as the type of *Amblema* Raf.

QUADRULA UNDULATA PILSBRYI (Marsh).

According to Utterback (135, p. 119) this is a synonym of *Q. perplicata quintardii* (Cragin).

Genus TRITOGONIA Agassiz, 1852.

The recent discovery of Sterki ('07, p. 48) that in the type species, *T. tuberculata,* all four of the gills are utilized for marsupia, removes the genus from the *Digenæ* of Simpson to the *Tetragenæ.* But in view of the remarkable dimorphism of the species, which is apparently a sexual and not a senile charcter as has been suggested by Ortmann, the subordination of the genus to *Quadrula* as proposed by him would seem to be inexpedient.

TRITOGONIA TUBERCULATA (Barnes).

Quadrula tritogonia Ortmann, Naut., XXII, 1909, p. 101.
Quadrula parkeri Geiser, The Academician I, 1911, p. 15.

The new names proposed by Ortmann and Geiser can not be used, even if the species is referred to *Quadrula.* If *Rotundaria,* with *tuberculata* Raf. as its type, be given generic rank, Barnes' name can still be used in *Quadrula* (Ortmann, 78, p. 116); but if not, the species would take the name of *obesa* Simp. (Vanatta, Naut., XXIII, 1910, p. 102).

Obliquaria verrucosa Raf. is identified as this species by Conrad and the shells so labelled in the Poulson collection are also that species according to Vanatta (140, p. 554). If identifiable from the original description Rafinesque's name has priority.

Genus AMBLEMA Rafinesque, 1820.

Amblema Rafinesque, Monographie, 1820, p. 314.
Crenodonta Schluter, Verz. meiner Conch., 1836, p. 33; Simpson, Syn., 1900, p. 766; Desc. Cat., 1914, p. 813.
Type: *Amblema costata* Raf.

Genus MEGALONAIAS Utterback, 1915

Megalonaias Utterback, Amer. Mid. Nat., IV, 1915, p. 123.
Type: *Unio heros* Say.

Genus ROTUNDARIA Rafinesque, 1820.

Rotundaria Rafinesque, Monographie, 1820, p. 308; Simpson, Syn., 1900, p. 794; Desc. Cat., 1914, p. 903.
Type: *Obliquaria tuberculata* Raf.

Genus FUSCONAIA Simpson, 1900.

Fusconaia Simpson, Syn., 1900, p. 784; Desc. Cat., 1914, p. 865.
Type: *Unio trigonus* Lea.

Genus PLETHOBASUS Simpson, 1900.

Plethobasus Simpson, Syn., 1900, p. 764; Desc. Cat., 1914, p. 805.
Type: *Unio æsopus* Green.

Genus PLEUROBEMA Rafinesque.

PLEUROBEMA ÆSOPUS (Green).

This species has been referred to *Obliquaria cyphya* Raf. by Conrad, Call, Ortmann and others. Vanatta (140, p. 556) states that the shell in the Poulson collection so labelled is this species. If identifiable from the original description, *cyphya* would have priority.

This species is the type of Simpson's section *Plethobasus,* which Ortmann (79, p. 259) has raised to generic rank.

PLEUROBEMA ARGENTEUM PANNOSUM Simpson.

This is a *Fusconaia* and a synonym of *F. ozarkensis* (Call) according to Ortmann (84, p. 63).

PLEUROBEMA BARNESIANUM (Lea).

Is a *Fusconaia* and includes *meredithii* Lea, *pudicum* Lea, *lyonii* Lea, *tellicoensis* Lea and *lenticulare* Lea according to Ortmann (84, p. 59).

PLEUROBEMA BIGBYENSE (Lea).

Is a *Fusconaia* and a variety of *F. barnesiana* (Lea) and includes *estabrookianum* Lea, *fassinans* Lea and *fassinans rhomboidea* Simp. according to Ortmann (84, p. 59).

PLEUROBEMA BREVE SUBELLIPTICUM Simpson.

Is a *Fusconaia* and a synonym of *F. ozarkensis* (Call) according to Ortmann (84, p. 63).

PLEUROBEMA CLAVUS (Lamarck).

Unio consanquineus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 16.
Unio anaticulus ohiensis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 21, pl. 10, fig. 3.

Vanatta (140, p. 555) states that *Unio elliptica* Raf., *Obliquaria scalenia* Raf. and *Pleurobema cuneata* Raf. as labelled in the Poulson collection are this species and expresses the opinion that *Pleurobema mytiloides* Raf. is also.

PLEUROBEMA CONRADI Vanatta.

This species was originally described by Conrad as *Unio maculatus,* but, as shown by Vanatta (140, p. 559), that name had already been used by Rafinesque for a variety of his *Unio nigra* and he has proposed *conradi* as a specific name for the *Pl. maculatum* (Con.) of Simpson's Desc. Catalogue.

PLEUROBEMA COR (Conrad).

The types of this species came from the Flint and Elk rivers in northern Alabama and as Frierson (44, p. 102) has shown is closely related to, if not identical with, *edgarianum* Lea or some other species of that group.

PLEUROBEMA CRUDUM (Lea).

Is a synonym of *Fusconaia barnesiana tumescens* (Lea) according to Ortmann (84, p. 59).

PLEUROBEMA ESTABROOKIANUM (Lea).

Is a *Fusconaia* and a synonym of *F. barnesiana bigbyensis* (Lea) according to Ortmann (84, p. 59).

PLEUROBEMA DOLLABELLOIDES (Lea).

Unio tornhatonii duckensis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 20, pl. 11, figs. 2a-c.

PLEUROBEMA FASSINANS (Lea).

This species and its variety *rhomboides* Simp. are Fusconaias and synonyms of *F. barnesiana bigbyensis* (Lea) according to Ortmann (84, p. 59).

PLEUROBEMA LENTICULARIS (Lea).

Is a *Fusconaia* and a synonym of *F. barnesiana* (Lea) according to Ortmann (84, p. 59).

PLEUROBEMA LEWISII (Lea).

That this species is distinct from *P. cor* (Con.), to which it was referred by Simpson, has been shown by Walker (160, p. 114) and *U. crapulus* Lea, if not distinct, is made a synonym.

PLEUROBEMA MEREDITHII (Lea).

Is a *Fusconaia* and a synonym of *F. barnesiana* (Lea) according to Ortmann (84, p. 59).

LAMPSILIS OZARKENSIS (Call).

Is a *Fusconaia* and includes *Pleurobema argenteum pannosum* Simp., *breve subellipticum* Simp. and *utterbacki* Fr. according to Ortmann (84, p. 63).

PLEUROBEMA PUDICUM (Lea).

Is a *Fusconaia* and a synonym of *F. barnesiana* (Lea) according to Ortmann (84, p. 59).

PLEUROBEMA SIMPSONI Vanatta.

Pleurobema simpsoni Vanatta, Pr. A. N. S. P., 1915, p. 559.

Originally described as *Unio striatus* Lea. Lea's name is not preoccupied by Rafinesque, but as suggested to me by Frierson it seems to have been by Goldfuss for a fossil species. I have not been able to examine, or to have examined, Goldfuss' original description. Lea refers to Goldfuss' species in his Synopsis, but as usual gives no exact citation. A palæontological friend has supplied the following references, which seem sufficient to settle the question. Goldfuss' description of his *Unio striatus* is to be found in his "Pertrefakten Deutschlands," II, 1839, p. 182, pl. 132, fig. 3. Bronn in his "Index Paleontologicus," II, p. 1345, includes the species among his *"omnia dubii generis"*. D'Orbigny in his "Prodrome de Paleontologie" includes it in his genus *Hesione* (1847). These facts were probably known to Lea and explain why he did not rename his species, as in other

instances he had claimed that the reference of the prior species in such cases to another genus "liberated" his own subsequent name. This under the Code is quite erroneous.

PLEUROBEMA UTTERBACKI Frierson.

Pleurobema utterbacki Frierson, Amer. Mid. Nat., IV, 1915, p. 197, pl. V, figs. 12a-b and pl. XX, figs. 63a-d.

Type locality: White River, Hollister, Mo.

This species is a *Fusconaia* and a synonym of *F. ozarkensis* (Call) according to Ortmann (84, p. 63).

Genus LEXINGTONIA Ortmann, 1914.

Lexingtonia Ortmann, Naut., XXVIII, 1914, p. 28.

Type: *Unio subplanus* Conrad.

"This genus stands near *Pleurobema* and *Elliptio* and differs from either chiefly by the subcylindrical, red placentæ, and by the beak sculpture."

Genus UNIO Retzius, 1788.

UNIO COMPLANATUS (Dill).

Unio pullatus majusculus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 27, pl. 8, figs. a-d.

Haas has recently (50, p. 54) figured the original type of Spengler's *Unio violaceus,* which appears to be an abnormal specimen of this species and proposes to give precedence to Spengler's name. I have shown elsewhere (162, p. 3) that this is not competent under the Code and that Dillwin's name should be retained.

UNIO CRASSIDENS Lam.

According to Ortmann (79, p. 266) this is the *Unio nigra* Raf. Vanatta (140, p. 555) states that the shell so labelled in the Poulson collection is this species. If identifiable from the original description, Rafinesque's name would have priority. Utterback (135, p. 199) has quoted me as authority for the statement that *Quadrula trapezoides* (Lea) should be considered as the *Unio crassidens* of Lamarck. I have expressed that opinion in correspondence and if the process of elimination could be strictly applied that would be the result. But Dr. Pilsbry has suggested that the provisions of the Code in regard to designating generic types apply equally well to the cases of composite species, of which this is an example, and that, if this rule does apply, Lea's statement (Obs., I, p. 199) of his examination of Lamarck's types in 1832 amounted to such a designation and can not now

be changed. Pending further consideration and final decision of the questions involved, it would be better to allow the accepted identification of *crassidens* to stand.

UNIO GIBBOSUS Barnes.

Unio propeverutus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 8, pl. 3, figs. 1a-c.

This species has been referred to *Unio dilatata* Raf. by Conrad and others. Vanatta states (140, p. 355) that both *U. dilatata* Raf. and *Obliquaria sinuata* Raf. as represented in the Poulson collection are this species. If identifiable from the original descriptions, both of Rafinesque's names have priority. *Dilatata* has page priority in his Monograph.

UNIO PUSILLUS Lea.

Lea's name is not preoccupied in *Unio* by *Obliquaria pusilla* Raf. (1820) as stated by Vanatta (140, p. 555) and will stand.

UNIO RAFINESQUEI Vanatta.

Unio fuscatus Lea, Simpson, Desc. Cat., 1914, p. 643.

Vanatta has shown (140, p. 559) that *fuscata* was twice used by Rafinesque as varietal names for species of *Unio* and has proposed the name given above for Lea's species.

UNIO TUOMEYI Lea.

Unio arctior fisheropsis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 15, pl. 5, figs. 3a-c.

Genus LASTENA Rafinesque, 1820.

From an examination of the soft anatomy, Ortmann has recently (81, p. 106) shown that this group belongs in the *Unioninæ* and not in the *Anodontinæ*.

Hemistena Raf. is a synonym according to Frierson, (42, p. 7).

LASTENA LATA Raf.

Unio dehiscens oriensopsis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 39, pl. 7, figs. 2a-b.

This variety (?) is made the type of a new genus or subgenus, *Sayunio*, the author does not seem to know which it should be considered.

Genus GONIDEA Conrad, 1857.

Ortmann has recently found from an examination of the soft anatomy (83, p. 50) that this genus belongs to the *Unioninæ*.

Subfamily ANODONTINÆ Ortmann, 1912.

Genus STROPHITUS Rafinesque, 1820.

STROPHITUS EDENTULUS (Say).

Anodonta foliopsis De Gregorio Moll. di aq. dul. di Amer., 1914, p. 33, pl. XI, figs. 4a-b.

There seems to be some uncertainty as to the proper name to be used for this species. Say described his *edentulus* in 1829. Swainson had already in 1822 described his *Anodon rugosus* from the "United States." Lea (Obs., I, p. 39) says that "it is well known" that Swainson's *rugosus* is the adult of Say's *undulata*, which has priority. Simpson, who considers *undulatus* and *edentulus* distinct, for some unexplained reason includes Swainson's species under *edentulus* as a synonym. Dall (32, p. 127) "on the face of the returns" gives the species to Swainson. I have not been able to examine Swainson's description and figure myself. Ortmann (78, p. 118) unites both species under the prior name of *undulatus*. If this is correct, the exact identity of Swainson's species becomes immaterial. Otherwise his description and figure should be critically examined again to determine, if possible, to which species it belongs.

STROPHITUS EDENTULUS SHÆFFERIANUS (Lea).

This seems to be a well marked race characteristic of the Tennessee drainage and as such entitled to varietal rank.

Genus ANODONTA Lamarck, 1799.

ANODONTA CATARACTA Say.

Anodonta ? subcylindracea propexilis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 33, pl. XII, figs. 1a-e.

ANODONTA GRANDIS Say.

Anodonta venusta De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 35, pl. XII, fig. 2.

This species founded on a single deformed valve is made the type of a new subgenus, *Nayadina*.

ANODONTA IMBECILIS Say.

Anodonta phalena De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 34, pl. XI, figs. 3a-e.

This species is *Lastena ohioensis* Raf. and a *Lastena* according to Utterback (135, p. 260).

ANODONTA SUBORBICULATA Say.

According to Utterback (135, p. 256) this species is a *Lastena*.

Genus ANODONTOIDES Simpson, 1898.

ANODONTOIDES FEUSSACIANUS (Lea).

Anodonta ferussaciana incertopsis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 34, pl. XI, fig. 5.

Genus LASMIGONA Rafinesque, 1831.

Symphynota Simpson (non Lea), Syn., 1890, p. 662; Desc. Cat., 1914, p. 480.

Frierson (Naut., XXVIII, 1914, p. 40) has shown that the original type of Lea's *Symphynota* was *Unio alatus* Say and it is therefore a synonym of *Proptera* Raf. and that consequently *Lasmigona* Raf. as the earliest available name becomes the generic type.

Subgenus PLATYNAIAS Walker, 1918.

Platynaias Walker, Occ. Pap., Mus. Zool., U. of M., No. 49, 1918, p. 1.
Type: *Symphynota compressa* Lea.

As the result of the disappearance of *Symphynota* Lea from this genus, the group typified by *S. compressa* Lea was left without any name and *Platynaias* has been proposed for it.

LASMIGONA COMPRESSA (Lea).

Unio compressa ? lindus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 14, pl. 6, figs. 1a-d.

Frierson (43, p. 57) has argued that Rafinesque's *Unio viridis* is this species and consequently has priority. This has been contested by Walker (157, p. 74). Vanatta (140, p. 554) states that Poulson's shell labelled *Unio viridis fuscata* from the Kentucky River, is the *Sym. viridis* Con. of Simpson's Synopsis. This I have verified from a personal inspection of the shell. For the reason stated by Walker, (l. c., p. 78) Lea's name is not superceded by *alasmodontina* Stimp. and will stand as the specific name.

LASMIGONA VIRIDIS Rafinesque.

For the conflicting opinions in regard to this species see the preceeding note. Under all of the evidence that has been adduced I think that Rafinesque's name should be given precedence, with *subviridis* Con. (24, App. p. 4), *viridis* "Con." Simp. and *tappanianus* Lea as synonyms.

Subgenus ALASMINOTA Ortmann, 1914.

Alasminota Ortmann, Naut., XXVIII, 1914, p. 41.
Type: *Margaritana holstonia* Lea.

Frierson (42, p. 7) has identified Rafinesque's *Alasmodon badium* as this species and has designated it as the type of *Sulcularia* Raf. If the species is identifiable from the original description and is Lea's *holstonia*, *Sulcularia* has precedence over *Alasminota*.

Genus ALASMIDONTA Say, 1818.

Subgenus PRESSODONTA Simpson, 1900.

I have recently (162, p. 2) proposed to supercede this name with that of *Calceola* Sw., 1840, on the ground of priority. Dr. Dall has since called my attention to the fact that *Calceola* had already been used by Lamarck in 1799 for a coral. Simpson's name will therefore stand.

Subgenus PROLASMIDONTA Ortmann, 1914.

Prolasmidonta Ortmann, Naut., XXVIII, 1914, p. 44.
Type: *Unio heterodon* Lea.

Subgenus PEGIAS Simpson, 1900.

According to Ortmann (81, p. 45) this group is a subgenus of *Alasmidonta*.

Subgenus RUGIFERA Simpson, 1900.

ALASMIDONTA MARGINATA Say.

Unio calceolus sciotincola De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 24, pl. IX, fig. 3.

Frierson (42, p. 7) has identified *Alasmodon scriptum* Raf. with this species, but Say's name has priority.

ALASMIDONTA RAVENELIANA (Lea).

Frierson (42, p. 7) has identified *Alasmodon atropurpureum* Raf. as being this species. If identifiable from the original description, it has priority.

On the basis of these identifications, he would substitute *Decurambis* Raf., 1831. for *Rugifera* Simp. as the subgeneric name.

Genus SIMPSONICONCHA Frierson, 1914.

Hemilastena Simpson, *non* Agassiz, Syn., 1900, p. 673; Desc. Cat., 1914, p. 323.
Simpsonaias Frierson, Naut., XXVIII, 1914, p. 7. (Preoccupied.)
Simpsoniconcha Frierson, Naut., XXVIII, 1914, p. 40.
Type: *Alasmodonta ambigua* Say.

For note on this name, see Walker, 162, p. 4.

Subfamily LAMPSILINÆ Ortmann, 1912.

Genus PTYCHOBRANCHUS Simpson.

Frierson, having identified (42, p. 7) *Obliquaria fasciolaris* Raf. with *P. phaseolus* (Hild.), has designated it as the type of *Ellipsaria* Raf. and gives the latter priority as the generic name.

PTYCHOBRANCHUS PHASEOLUS (Hild.).

Unio compressissimus performosus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 23, pl. V, fig. 2.

Unio lanceolatus blandus De Gregorio, Ibid, p. 22, pl. VIII, fig. 2.

Unio imperitus De Gregorio, Ibid, p. 15, pl. IX, fig. 1.

Say, Conrad and Frierson (1914, p. 7) have identified the *Obliquaria fasciolaris* Raf. as this species and Vanatta (140, p. 554) states that the shell so labelled in the Poulson collection is also that species. If identifiable from the original description, Rafinesque's name would have priority.

PTYCHOBRANCHUS SUBTENTUS (Say).

Unio subteritus purcheornatus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 31, pl. IX, fig. 2.

Genus CYPROGENIA Agassiz, 1852.

CYPROGENIA IRRORATA (Lea).

Is *Obovaria stegaria* Raf. according to Conrad and Vanatta (140, p. 554) states that the shell so labelled in the Poulson collection is this species. If identifiable from the original description *stegaria* has priority.

Genus PLAGIOLA (Rafinesque, 1819) Agassiz.

PLAGIOLA DONACIFORMIS (Lea).

Unio zig-zag illius De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 11, pl. IV, fig. 3.

Is an *Amygdalonaias* according to Ortmann (81, p. 67).

PLAGIOLA ELEGANS (Lea).

Unio elegans elegantopsis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 11, pl. IV, fig. 6.

Unio elegans magnelegans De Gregorio, Ibid, p. 11, pl. V, figs. 1a-c.

This species is an *Amygdalonaias* according to Ortmann, (79, p. 328).

Say and Conrad have identified the *Truncilla truncata* as this species. Vanatta states (140, p. 553) that both the *T. truncata* Raf. and *Unio metaplata* Raf. as represented in the Poulson collection are this species. If identifiable from the original description, *truncata* would have precedence. *Metaplata* is subsequent to both.

PLAGIOLA SECURIS (Lea).

Both *Obliquaria depressa* Raf. and *O. lineolata* Raf. are identified by Say and Conrad as this species and both authors give the preference to *lineolata* as the specific name. According to Vanatta (140, p. 553) these two species and also *O. ellipsaria* Raf. as represented in the Poulson collection are *securis* Lea. If identifiable from the original description, any one of Rafinesque's names would have priority.

Genus PARAPTERA Ortmann, 1911.

The type of this genus is *U. gracilis* Bar. If, as claimed by Frierson and others, this is the *Unio fragilis* Raf., which the latter in 1831 made the type of his genus *Lasmonos*, this name would have priority over *Paraptera*.

Frierson (42, p. 6) has suggested that if *leptodon* Raf. should prove to belong to this genus, *Leptodea* Raf., of which *leptodon* is the type, would have to be used.

Genus OBOVARIA Rafinesque, 1819.

OBOVARIA CIRCULUS (Lea).

Obliquaria subrotunda Raf. has been identified as this species by Say and Conrad and the latter adds *Obovaria striata* Raf. as a synonym. The specimens under both of these names in the Poulson collection, according to Vanatta (140, p. 552), are this species. If identifiable from the original descriptions, either of Rafinesque's names would have priority.

OBOVARIA ELLIPSIS (Lea).

Conrad has identified *Amblema olivaria* Raf. as this species and according to Vanatta (140, p. 553) so also is the shell in the Poulson collection under that name. If identifiable from the original description Rafinesque's name has priority.

OBOVARIA LENS (Lea).

According to Ortmann (79, p. 323) this species is not specifically distinct from *O. circulus* (Lea). Vanatta (140, p. 552) states that the shell labelled *Unio levigata* Raf. in the Poulson collection is this species. If identifiable from the original description, *levigata* would have precedence

OBOVARIA RETUSA (Lam.).

According to Vanatta (140, p. 552) this is the *Obovaria torsa* Raf. of the Poulson collection.

Genus CARUNCULINA Simpson, 1898.

This group is clearly entitled to generic rank as stated by Ortmann (81, p. 68), who has shown that the type is *Unio parvus* Bar. and not *texasensis* Lea.

Frierson (42, p. 7) has identified *C. glans* (Lea) as the *Unio (Toxolasma) lividus* Raf. and consequently substitutes *Toxolasma* Raf. for *Caruncula* Simp.

Genus LAMPSILIS Rafinesque, 1820.

LAMPSILIS ALATA (Say).

Vanatta (140, p. 552) states that the shell labelled *Metaptera megaptera* Raf. in the Poulson collection is this species. *Alata* is the type of *Proptera* Raf.

LAMPSILIS ANODONTOIDES (Lea).

This species belongs to *Lampsilis* s. s. according to Ortmann (79, p. 346). It has been identified with *U. teres* Raf. by Say, Conrad and others.

LAMPSILIS ARKANSENSIS (Lea).

This species is a *Micromya* according to Ortmann (81, p. 54).

LAMPSILIS AMŒNA (Lea).

Is a synonym of *L. nebulosa* (Con.) according to Ortmann (81, p. 64).

LAMPSILIS BOREALIS (Gray).

The citation of this species from Oneida Lake by Baker, (9, p. 257) has proved to be erorneous. See Baker, (10, p. 75).

LAMPSILIS BREVICULA (Call).

Is a *Micromya* according to Utterback (135, p. 434).

LAMPSILIS CAPAX (Green).

Is a *Proptera* according to Coker and Surber, (21, p. 179) and Ortmann (81, p. 67).

LAMPSILIS CARIOSA (Say).

Unio pallescens Lea var. De Gregorio, Moll. di aq. dul. di Amer., p. 9, *non* Lea, 1845.

LAMPSILIS CONSTRICTA (Con).

Is a *Micromya* according to Ortmann (81, p. 66).

LAMPSILIS ELLIPSIFORMIS (Con.).

Is a *Nephronaias* according to Utterback (135, p. 341).

LAMPSILIS FALLACIOSA Smith.

Is a *Lampsilis* s. s. and doubtfully distinct from *L. anodontoides* according to Ortmann (79, p. 347). But Surber (127, p. 5) states that the glochidia of the two species differ both in size and shape.

CARUNCULINA GLANS (Lea).

Unio castus mirus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 27.

Frierson (42, p. 7) has identified *Unio* (*Toxoclasma*) *lividus* Raf. as this species. If identifiable, and it is not at all certain that it might not be the *pullus* of Lea, it would have priority. If it can not be definitely determined what species it is, it should be rejected for indefiniteness.

LAMPSILIS GRACILIS Barnes.

This species has been identified by Frierson (42, p. 7) and others as the *Unio fragilis* Raf. (1820) and *Lasmonos fragilis* Raf. (1831) and either of these names, if identifiable from the original description, would have priority. The example under this name in the Poulson collection according to Vanatta (140, p. 552) is *gracilis* Bar.

Fragilis Raf. (1831) is the monotype of his genus *Lasmonos*.

LAMPSILIS IRIS (Lea).

Is a *Micromya* according to Ortmann (79, p. 341).

LAMPSILIS LEPTODON (Raf.).

Unio shepardianus f. duttonianus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 25.

This species is the type of *Leptodea* Raf. by designation (Frierson, 42, p. 6).

LAMPSILIS LIENOSA (Con.).

Is a *Micromya* according to Ortmann (79, p. 340).

LAMPSILIS LIGAMENTINA (Lam.).

Unio tecomensis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 26.

This species was at first referred to *Obovaria* by Ortmann (78, p. 119) and later to *Nephronaias* (79, p. 325). It should rather be referred to *Actinonaias* F. and C.

According to the specimens in the Poulson collection (Vanatta, 140, p. 551) *U. crassa* Raf., *fasciata* Raf. and *pallens* Raf. are this species.

LAMPSILIS LUTEOLA (Lam.).

Vanatta (140, p. 551) states that *L. fasciola* Raf. is this species.

LAMPSILIS NEBULOSA (Con.).

Is a *Micromya* according to Ortmann (81, p. 64).

LAMPSILIS NIGERRIMA (Lea).

Is a variety of *L. concestator* Lea according to Frierson (41, p. 135).

LAMPSILIS OCCIDENTALIS (Con.).

Is *Ptychobranchus clintonensis* Simp. and has priority according to Utterback (135, p. 317).

LAMPSILIS ORBICULATA (Hild.).

Belongs to *Lampsilis* s. s. and does not group with *L. ligamentina* Lam. according to Ortmann (79, p. 353).

LAMPSILIS OZARKENSIS (Call).

Is a *Nephronaias* according to Utterback (135, p. 344). Ortmann (84, p. 62) has more recently determined it to be a *Fusconaia*.

LAMPSILIS PARVA (Bar.).

Unio pertenuis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 31, pl. VI, figs. 4a-f, *non* Lea, 1863.

This species is the true type of *Carunculina* according to Ortmann (81, p. 68).

LAMPSILIS PERDIX (Lea).

Is a *Nephronaias* according to Ortmann (79, p. 326). It is rather an *Actinonaias*.

LAMPSILIS PERPURPUREA (Lea).

Is a *Micromya* according to Ortmann (81, p. 63).

LAMPSILIS PICTA (Lea).

Is a *Micromya* according to Ortmann (79, p. 342).

LAMPSILIS PLEASII (Marsh).

Is a *Nephronaias* according to Utterback (135, p. 343). It is rather an *Actinonaias*.

LAMPSILIS RADIATA (Gmel.).

Unio muhlfeldianus plurimaffinis De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 8, pl. III, figs. 2a-d.

LAMPSILIS RADIATA ONEIDENSIS Baker.

Lampsilis borealis Baker, Tech. Pub. N. Y. Coll. For., 4, 1916, p. 257, fig. 44, nos. 1-4.

Lampsilis radiata oneidensis Baker, Naut., XXX, 1916, p. 74, pl. II.

Type locality: Oneida Lake, N. Y.

LAMPSILIS RECTA (Lam.).

Unio sageri Conrad, Mon., VI, 1836, p. 53, pl. xxix, fig. 1.

Lampsilis recta sageri Simpson, Desc. Cat., 1914, p. 96.

Lamarck's type came from Lake Erie and is the small form characteristic of the Great Lakes that Conrad described as *Unio sageri*. The large, normal form from the Ohio and elsewhere may be distinguished under Rafinesque's name.

LAMPSILIS RECTA LATISSIMA (Raf.).

Unio latissima Rafinesque, Mon., 1820, p. 297, pl. lxxx, figs. 14-15.
Unio angustatus cuniculus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 22, pl. X, fig. 1.
Type locality: Ohio River.
This is the form represented in the Poulson collection (Vanatta 140, p. 551).

LAMPSILIS SIMPSONI Ferriss.

Belongs to *Lasmonos* Raf. according to Utterback (135, p. 367).

LAMPSILIS SUBROSTRATA (Say).

Belongs to *Eurynia* s. s. according to Ortmann (81, p. 55).

LAMPSILIS TENERA (Ravenel, Mss.) Mazyck.

Lampsilis tenerus (Rav. Mss.) Mazyck, Cat. Moll. S. C., 1913, p. 23.
Type locality: Santee Canal, St. John's, Berkeley, S. C.
The specific name is preoccupied by Lea, 1840.

LAMPSILIS TRABALIS (Con.).

Is a *Micromya* according to Ortmann (79, p. 340).

LAMPSILIS VANUXEMENSIS (Lea).

Is a *Micromya* according to Ortmann (79, p. 342; 81, p. 65).

LAMPSILIS VENTRICOSA (Bar.).

According to Say and Conrad this is the *L. cardium* Raf., 1820, and if so ,the latter name has priority. Vanatta (140, p. 551) states that the shell so labelled in the Poulson collection is the *ventricosa* Bar.

According to Ortmann (79, p. 351) it "is probably only a variety of *L. ovata* (Say).

LAMPSILIS VENTRICOSA COHONGORONTA Ortmann.

Lampsilis ventricosa cohongoronta Ortmann, Naut., XXVI, 1912, p. 53.
Type locality not specified. Found in the Potomac River, Hancock, Washington Co., Md., and in the South Branch of the Potomac at Southbranch and Romney, W. Va., and in the Shenandoah River, Harper's Ferry, W. Va.

LAMPSILIS VENTRICOSA SATURA (Lea).

Frierson (41, p. 136) says that this is not a variety of *L. ventricosa,* but is the same as *L. excavata* Lea and has priority as the proper specific name. I do not agree with this. Ortmann (81, p. 56) deals with it as a form of *ventricosa* and intimates a "suspicion" that it may prove to be a distinct species.

LAMPSILIS VENUSTA (Lea).

Is a variety of *L. ellipsiformis* (Lea) according to Utterback (135, p. 343).

LAMPSILIS VIBEX (Con.).

Is a *Micromya* according to Ortmann (79, p. 340).

Genio MICROMYA (Agassiz, 1852) Simpson.

MICROMYA CÆLATA Conrad.

Unio propecælatus De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 30, pl. VIII, figs. 1a-d.

This species has been identified by Frierson (42, p. 7) and Ortmann (82, p. 39) as *Unio (Lemiox) rimosus* Raf. and the latter (l. c.) has raised *Lemiox* to generic rank. The identification seems too doubtful (Walker, 162, p. 4) to be relied upon, the species should therefore retain Conrad's name and a new generic name proposed.

MICROMYA FABALIS (Say).

Unio donacopsis De Gregorio, Moll. di dul. di Amer., 1914, p. 30, pl. X, figs. 5a-b.

Genus TRUNCILLA Rafinesque, 1819.

TRUNCILLA CURTISII Frierson and Utterback.

Truncilla curtisii Frierson and Utterback, Am. Mid. Nat., IV, 1916, p. 453, pl. VI, figs. 14a-d, pl. XXVIII, figs. 109A-D.

Type locality: White River, Hollister, Mo.

This is the form that was collected by Ferriss in 1900 and distributed by him as *T. deviata* (Anth.). It has also been found in Bear Creek, Franklin Co., Ala., a tributary of the Tennessee. It does not seem to be more than a light colored form of that species.

TRUNCILLA LEFEVREI Utterback.

Truncilla lefevrei Utterback, Am. Mid. Nat., IV, 1916, p. 455, pl. VI, figs. 13 -d, pl. XXVIII, figs. 108A-D.

Type locality: Black River, Williamsville, Mo.

TRUNCILLA FOLIATA (Hild.).

This species has been identified as Rafinesque's *Obliquaria flexuosa* by Conrad and the specimen in the Poulson collection under that name is stated by Vanatta (140, p. 550) to be this species. If identifiable from the original description, Rafinesque's name would have priority. It has also been identified by Frierson (42, p. 7) as Rafinesque's *Epioblasma biloba*.

TRUNCILLA BREVIDENS (Lea).

Vanatta (140, p. 550) states that the shell in the Poulson collection labelled *Obliquaria interrupta* Raf. is this species. If identifiable from the original description, Rafinesque's name has precedence.

TRUNCILLA PERPLEXA (Lea).

This species has been identified by Conrad and others as *Amblema torulosa* Raf. and *Amblema gibbosa* Raf. According to Vanatta (140, p. 550) the shells so labelled in the Poulson collection are this species. Either name, if identifiable from the original description, would have priority.

TRUNCILLA SULCATA (Lea).

Unio stewardsoni stevensoni De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 15, pl. VI, fig. 3.

Unio propesulcatus De Gregorio, Ibid, p. 30, pl. X, fig. 2.

Vanatta (140, p. 550) states that the shell in the Poulson Collection under the name of *Obliquaria obliquata* Raf. is this species. If identifiable from the original description, it would take precedence.

TRUNCILLA TRIQUETRA Rafinesque.

Unio triangularis pergibbosa De Gregorio, Moll. di aq. dul. di Amer., 1914, p. 10, pl. II, fig. 4.

Unio triangularis longiusculus De Gregorio, Ibid, p. 10, pl. II, fig. 5.

TRUNCILLA TRIQUETRA TRIANGULARIS (Barnes).

Barnes' types of his *Unio triangularis* came from Bois Blanc Island in the Detroit River and the form is fairly entitled to varietal rank, being like nearly all of the *Unionidæ* of the Great Lakes a characteristically depauperate race.

TRUNCILLA WALKERI Wilson and Clark.

Truncilla walkeri Wilson and Clark, Bur. of Fish. Doc. No. 781, 1914, p. 46, pl. I, fig. 1.

Type locality: East Fork of Stone's River, Walterville, Tenn.

Subgenus DYSNOMIA Agassiz, 1852.

Frierson (42, p. 7) identifies Rafinesque's *Unio* or *Epioblasma biloba* with *T. foliata* (Hild.) and consequently replaces Agassiz' subgeneric name by *Epioblasma* Raf.

Genus *incertæ sedis.*

COKERIA Marshall, 1916.

Cokeria Marshall, Naut., XXIX, 1916, p. 133.

Type: *Cokeria southalli* Marshall.

COKERIA SOUTHALLI Marshall.

Cokeria southalli Marshall, Naut., XXIX, 1916, p. 133, pl. IV.

Type locality: James River, Huron, S. D.

This genus and species are founded on an unique specimen collected by the U. S. Bureau of Fisheries. It seems to combine the characters of both *Quadrula* and *Lampsilis,* although the preponderance of the characters appear to be Quadruline. Indeed, but for the hinge teeth, which are quite like those of *Lampsilis,* it would be considered a *Quadrula.* It is quite possibly an abnormality of *Quadrula undulata* (Bar.). Unfortunately nothing is known of the soft parts. Additional material is greatly to be desired.

Family CYRENIDÆ.

Genus CYRENA Lamarck, 1818.

Section POLYMESODA Rafinesque, 1820.

CYRENA ALABAMENSIS Clessin.

Cyrena alabamensis Clessin, Con. Cab., Cycladeen, 1869, p. 114, pl. XVIII, figs. 3-4.

Type locality: Alabama.

CYRENA DONACIFORMIS Sowerby.

Cyrena donaciformis Sowerby, Con. Icon., Cyrena, 1878, p. 108, pl. XIX, fig. 108.

Type locality: Florida.

Is *floridana* Con. according to von Martens (Zool. Rec., Moll., 1877, p. 81) and Dall (29, p. 1447).

CYRENA PROTEXTA Conrad.

Cyrena protexta Conrad, Am. J. of Con., V, 1869, p. 107, pl. XII, fig. 3.

Type locality: Tampa Bay, Fla.

Is *floridana* Con. according to Tryon, (A. J. of C., V, 1870, p. 227) and Dall (29, p. 1447).

Family SPHÆRIIDÆ.

Sterki's "Preliminary Catalog" (125, p. 429) has brought the subject down to July 1, 1916.

For valuable papers on the anatomy, reproduction and growth of *Sphærium* and *Musculium*, see Drew (36, p. 173) and Gilmore (46, p. 16).

Genus SPHÆRIUM Scopoli, 1777.

SPHÆRIUM LENTICULARE Sowerby.

Sphærium lenticularis Sowerby, Con. Icon., Sphærium, Sp. 6, pl. I, fig. 6.
Type locality: ?

SPHÆRIUM MAGNUM Sterki Mss.

Sphærium magnum "Sterki", Springer, Pr. A. N. S. P., 1902, p. 513.

This undescribed species is quoted from Arroyo Pecos, Las Vegas, N. M. (pleistocene) by Springer.

SPHÆRIUM MEDIUM (Sowerby).

Cyclas medium "Sowerby", Richardson, Fauna Bor. Amer. III, 1836, p. 316.
Type locality: Methy Lake, Athabaska.

Probably never described, see Dall (32, p. 140).

SPHÆRIUM RUGOSUM "Whitmore" Sowerby.

Sphærium rugosum "Whitmore" Sowerby, Con. Icon., Sphærium, Sp. 16, pl. II, fig. 16.
Type locality: ?

SPHÆRIUM STAGNICOLUM (Sowerby).

Cyclas stagnicola "Sowerby" Richardson, Fauna Bor. Amer. III, 1836, p. 316.
Type locality: Methy Lake, Athabaska.

Probably never described, see Dall (32, p. 140).

Genus MUSCULIUM Link, 1807.

Musculium Link, Beschr. Rostock Samm I, 1807, p. 152.
Calyculina Clessin, Mal. Blätt., XIX, 1871, p. 150.
Primella Cooper, Pr. Cal. Acad. Sci., (2), III, 1891, p. 82.

MUSCULIUM COOPERIANUM (Prime) Mss.

Sphærium cooperianum Prime, Cat. Corbic., Am. J. of Con., V, 1869, p. 152.
Type locality: Johnson's Pass, Eldorado Co., Cal.

Listed as a new species, but never described. Probably the young of *M. raymondi* according to Cooper (26, p. 81).

MUSCULIUM ERRANS (Lewis).

Cyclas errans Lewis, *Ubi ?*

Lewis (Pr. A. N. S. P., 1872, p. 105) says that he "proposed" this species a number of years before, but that Prime considered it a synonym of *rosaceum*. That from further study, he is "induced" to reclaim his species. I have been unable to find any other reference to the species.

Genus PISIDIUM C. Pfeiffer, 1821.

The use of *Corneocyclas* Fer. for this genus proposed by Dall (30, p. 7 and 29, p. 1459) is disputed by Woodward (165, p. 367 and 166, p. 1) and has not been followed by Sterki (125, p. 473) and until the question has been definitely settled, it seems preferable to use the name that has been in common use for so many years.

PISIDIUM BOREALE Westerlund.

Pisidium boreale Westerlund, Kongl. Sv. Vet. Ak. Forh., 1877, p. 70, fig. 23.

Type locality: Lusino, Siberia. ? Port Clarence, Alaska.

PISIDIUM CALIFORNICUM (Newcomb ?).

Listed by Berry (Naut., XXIII, 1909, p. 79) from Bluff Lake, San Bernardino Co., Cal. I have not been able to find any other reference to it.

PISIDIUM COMPRESSUM LIMNICOLUM Sterki.

Pisidium compressum limnicolum Sterki, Naut., XIX, 1905, p. 81.

Type locality: Fox River, Wis.

PISIDIUM COMPRESSUM SMITHII Sterki.

Pisidium compressum smithii Sterki, Naut., XIX, 1905, p. 83.

Type locality: Shoal Creek, Ala.

PISIDIUM NOVEBORACENSE PROCLIVE Sterki.

Pisidium noveboracense proclive Sterki, Naut. XIX, 1906, p. 119.

Type locality: New Philadelphia, O.

PISIDIUM OBTUSALE C. Pfeiffer.

This European species has been listed from near Lake James, Steuben Co., Ind. by Sterki (Naut., XVII, 1903, p. 43).

PISIDIUM SIBIRICUM Westerlund.

Pisidium sibiricum Westerlund Nachr. Blätt. Gess. 1876, p. 103; Clessin, Con. Cab., Cycladeen, 1877, p. 66, pl. VII, figs. 15-17.

Type locality: Yenesei River, Siberia.

? Port Clarence, Alaska according to Dall (32, p. 144). Dall's reference for this species in K. Svenska Vet. Ak. Forh. is erroneous. It should be p. 69, fig. 21, not p. 70, fig. 23.

Family CYRENELLIDÆ.

Genus CYRENELLA Deshayes, 1835.

CYRENELLA FLORIDANA (Dall).

Cyrenoida floridana Dall, Naut. X, 1896, p. 52; Pr. U. S. N. M. XXIII, 1901, p. 829, pl. XLII, fig. 7.

Type locality not specified.

Habitat: Brunswick, Ga., south to the Everglades on the east, and, on the west, north to Charlotte Harbor and vicinity.

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ADDENDA

Genus IO Lea, p. 149.

For an elaborate paper on "The Variations and Ecoolgical Distribution of the Snails of the Genus Io" by Charles C. Adams, see, Memoirs of the National Academy of Sciences, XII, 1915, Part II, Second Memoir.

The following "races and forms" are recognized and described:—

NAME.	PAGE.	TYPE LOCALITY.
Powellensis C. C. Ads.	11.	Powell R., Olinger, Va.
Clinchensis C. C. Ads.	11.	Clinch R., Cleveland, Va.
Fluvialis Say.	11.	N. Fork, Holston R., Saltville, Va.
Verrucosa Rve.	12.	S. Fork, Holston R., Bluff City, Tenn.
Lyttonensis C. C. Ads.	12.	Powell R., Pennington Gap, Va.
Paulensis C. C. Ads.	12.	Clinch R., St. Paul, Va.
Recta Rve.	12.	Holston R., Kingsport, Tenn.
Brevis Anth.	12.	Clinch R., Kyle Ford, Tenn.
Spinosa Lea.	13.	Holston R., Morristown, Tenn.
Unakensis C. C. Ads.	13.	Nolichucky R., Conkling, Tenn.
Nolichuckyensis C. C. Ads.	13.	Nolichucky R., White Pine, Tenn.
Angitremoides C. C. Ads.	14.	Tennessee R., Looney's Id., Knoxville, Tenn.
Loudonensis C. C. Ads.	14.	Tennessee R., Loudon, Tenn.
Turrita Anth.	14.	Tennessee R., Bellefonte, Tenn.

Genus STROPHITUS Rafinesque, p. 56.

Add:—

Section JUGOSUS Simpson, 1914.

Shell with the dorsal slope strongly subradially plicate; teeth unusually strong.

Type: *S. wrightianus* Walker.

Genus SPHÆRIUM Scopoli, p. 188.

In his "Preliminary Catalog of the North American Sphæriidæ (125, p. 472) Sterki recognizes three subgenera, but they are not so defined as to be included in the systematic portion of this paper. They are:—

Sphæriastrum Bourguignat.	Type: *S. rivicolum* (Leach).
Cyrenastrum Bourguignat.	Type: *S. solidum* Normand.
Corneola Clessin.	Type: *S. corneum* (Linné).

The first is not represented in our fauna.

As *Tellina cornea* L. is the type of the genus *Sphærium, Corneola* Cless. is equivalent to *Sphærium s. s.* and is entirely superfluous.

Subject to this amendment, his arrangement is the same as that proposed by Dall (30, p. 7) in 1903.

Genus PISIDIUM C. Pfeiffer, p. 189.

Dall (l. c.) has proposed the following arrangement for *Corneocyclas* (*Pisidium*).

Genus CORNEOCYCLAS Ferussac, 1818.

Subgenus *Corneocyclas s. s.*	
Section *Corneocyclas* s. s.	Type: *C. pusilla* Gmelin.
Section *Phymesoda* Rafinesque.	Type: *Tellina virginica* Gmelin.
Section *Pisidium* C. Pfeiffer, 1821.	Type: *Tellina amnica* Müller.
Section *Cyclocalyx* Dall, 1903.	Type: *Pisidium scholtzi* Clessin.
Subgenus *Cymatocyclas* Dall, 1903.	Type: *Pisidium compressum* Prime.
Subgenus *Tropidocyclas* Dall, 1903.	Type: *Pisidium henslowianum* Sheppard.

Only the typical species are mentioned and no attempt is made to distribute the North American species among the different groups.

Sterki (l. c.) tentatively and without definition proposes the following "groups":—

Fluminina Clessin, 1879.	Type: *P. amnicum* (Müll).

This is equivalent to *Pisidium s. s.* and therefore unnecessary.

Lacustrina Sterki, 1916.	Type: *P. idahoense* Roper.
Rivulina (Clessin, 1879) Sterki.	Type: *P. supinum* A. Schmidt.
Fontinalina Sterki, 1916.	Type: *P. fontinale* Pfr.
Fossarina Clessin, 1879 (restricted).	Type: *P. obtusale* Pfr.

PLEUROCERA, p. 151.

PLEUROCERA KNOXENSE (Lea).

According to Tryon (134, p. 427) this name will take the place of *P. modestum* (Lea), 1862, because *Io modesta* Lea, 1861, is also a *Pleurocera*. This, of course, is conditional upon the latter proving to be a valid species.

PLEUROCERA PARKERI Tryon.

This name has been proposed by Tryon (134, p. 427) for *Trypanostoma tortum* Lea (Ibid, p. 84), 1862, on the ground that *Melania torta* (Ibid, p. 117), 1845, has priority, being also a *Pleurocera*.

INDEX

Acella Hald. 6, 8
Acroloxus Beck 118
Actinonaias C. and F. 66, 75
Acuta (Pleurocera) Raf. 36, 151
Acutifilosa (Goniobasis) Stearns 154
Acutifilosa siskiyouensis Pils. 154
Acutifilosa (Melania) Stearns 154
Acutissima (Amnicola) Frfld. 137
Acutissima (Hydrobia) Frfld. 137
Acutissima (Paludestrina) Frfld. 137
Acutocarinata (Melania) Lea 149
Acutum (Cyclostoma) Drap. 29
Adusta (Goniobasis) Anth. 157
Æquicostata (Bythinella) Pils. 137
Æquicostata (Paludestrina) Pils. 137
Æsopus (Pleurobema) Green 171
Æsopus (Unio) Green 50, 171
Affine (Pleurocera) Lea 151
Affine (Trypanostoma) Lea 151
Alabamensis (Amphigyra) Pils. 22, 123
Alabamensis (Cyrena) Cless. 187
Alabamensis (Planorbis) Pils. 95, 98
Alabamensis avus (Planorbis) Pils. 95
Alampetis v. Marts. 106
Alasmidonta Say 56, 62, 178
Alasminota Ort. 59, 61, 177
Alasmodontina (Complanaria) Stimp. ... 177
Alata (Lampsilis) Say 180
Alatus (Unio) Say 72, 177
Albanyensis (Goniobasis) Lea 154
Albofilata (Physa) Ancey 106, 110
Albus (Planorbis) Müll. 13, 94, 100
Aldrichi (Bythinella) C. and B. 137
Aldrichi (Paludestrina) C. and B. 137
Aldrichi (Somatogyrus) Walk. 142
Altilis (Melania) Lea 33
Altipetum (Pleurocera) Anth. 151
Altonensis (Physa) Lea 106, 110
Altus (Ancylus) Tryon 117
Altus (Lanx) Tryon 117
Alveare (Pleurocera) Con. 151
Ambigua (Alasmodonta) Say 64, 178
Amblema Raf. 42, 47, 170, 171
Ambloxis Raf. 127
Ammon (Planorbis) Gld. 103
Amnica (Tellina) Müll. 88, 200
Amnicola G. and H. 28, 133
Amnicolidæ 23, 27, 132
Amnicolinæ Gill 27, 28, 133
Amnicoloides (Somatogyrus) Walk. 143
Amnicum (Pisidium) Müll. 200
Amœna (Lampsilis) Lea 181
Amphigyra Pils. 22 123
Ampullacea (Physa) Gld. 107
Ampullacea columbiana (Physa) Hemp. . 107
Ampullaria Lam. 23, 123
Ampullariidæ 23, 123
Amygdalonaias C. and F. 65, 69
Amygdalus (Physa) Sby. 107
Anaticulus ohiensis (Unio) DeG. 172
Anatina (Physa) Lea 107, 113
Ancillaria (Physa) Say 106, 107, 110, 115
Ancillaria crassa (Physa) Walk. 107
Ancillaria magnalacustris (Physa) Walk. . 107
Anculosa Say 34, 37, 127, 149, 163
Ancylidæ 5, 16, 117
Ancyliformis (Gundlachia) Pfr. 20, 121
Angitrema Hald. 35, 149, 150
Angitremoides (Io) C. C. Ads. 199
Angulata (Angitrema) Weth. 150
Angulata (Anodonta) Lea 54
Angulata (Lithasia) Weth. 150
Angulata (Tulotoma) Lea 130
Angustatus cuniculus (Unio) DeG. 184
Anodonta Lam. 55, 56, 176
Anodontinæ Ort. 42, 54, 176
Anodontoides Simp. 55, 57, 177
Anodontoides (Lampsilis) Say 181
Anthonyi (Anculosa) Budd 36
Anthonyi (Eurycœlon) Budd 149
Antrosus (Planorbis) Con. 95, 100
Antrosus angistomus (Planorbis) Hald. .. 95
Antrosus arostookensis (Planorbis) Pils. . 95
Antrosus corrugatus (Planorbis) Curr. ... 95
Antrosus percarinatus (Planorbis) Walk.. 95
Antrosus portagensis (Planorbis) Baker . 96
Antrosus royalensis (Planorbis) Walk. .. 96
Antrosus striatus (Planorbis) Baker 96
Antrosus unicarinatus (Planorbis) Hald. . 96
Apicina (Lymnæa) Lea 93
Aplectoides (Physa) Sterki 107
Aplexa Flem. 15, 16, 116
Arachnoidea (Goniobasis) Anth. 155
Arata (Goniobasis) Lea 155
Aratum (Pleurocera) Lea 151
Arcidens Simp. 55, 57
Arcticus (Planorbis) Möll. 96
Arctior fisheropsis (Unio) DeG. 175
Arcula (Margaritana) Lea 64
Argenteum pannosum (Pleurobema) Simp. 171, 173
Arizonensis (Planorbis) P. and F. 96
Arkansensis (Anculosa) Hink. 163
Arkansensis (Lampsilis) Lea 181
Arkansia O. and W. 55, 58
Armiger Hartm. 13, 94
Armigera (Melania) Say 35, 149
Armigera (Segmentina) Say 104
Armigera campestris (Segmentina) Dawson 104
Armigerus (Planorbis) Say 14
Askewi (Quadrula) Marsh 166
Asperrimus (Unio) Lea 167
Aspidobranchia 37
Aterina (Goniobasis) Lea 155
Athleta (Goniobasis) Anth. 158
Atropurpureum (Alasmodon) Raf. 178
Attenuata (Amnicola) Hald. 138
Attenuata (Bythinella) W. G. Binn. 138
Augustina (Amnicola) Pils. 133
Aurea (Physa) Lea 108, 110
Aureus (Somatogyrus) Tryon 143
Auricularia (Lymnæa) L. 7, 93

Baculoides (Goniobasis) Lea 155
Baculum (Melania) Anth. 155
Badium (Alasmodon) Raf. 177
Bairdiana (Goniobasis) Lea 160
Bakeriana (Amnicola) Pils. 133
Bakeriana nimia (Amnicola) Pils. 133
Bariosta Raf. 170
Barnesiana (Fusconaia) Lea 171, 172, 173
Barnesiana bigbyensis (Fusconaia) Lea 172, 173
Barnesiana tumescens (Fusconaia) Lea .. 172
Barnesianum (Pleurobema) Lea 171
Basommatophora 5, 93
Beadleana (Quadrula) Lea 166
Bengalensis (Cyrena) Lam. 85
Bengalensis (Viviparus) Lam. 126
Bentonensis (Goniobasis) Lea 155
Berendti (Planorbis) Tryon 105
Biangulatus (Planorbis) Sby. 95
Biangulatus (Somatogyrus) Walk. 143
Bicarinata (Valvata) Lea 130
Bicarinata connectans (Valvata) Walk. .. 130
Bicarinata normalis (Valvata) Walk. 130
Bicarinata perdepressa (Valvata) Walk. . 130
Bicarinatus (Planorbis) Say 11, 94, 95
Bicarinatus angistomus (Planorbis) Hald. 95
Bicarinatus arostookensis (Planorbis) Pils. 95
Bicarinatus corrugatus (Planorbis) Curr.. 95
Bicarinatus major (Planorbis) Beck. 95
Bicarinatus major (Planorbis) Walk. 95
Bicarinatus minor (Planorbis) Beck. 95
Bicarinatus percarinatus (Planorbis) Walk. 95
Bicarinatus portagensis (Planorbis) Baker 96
Bicarinatus royalensis (Planorbis) Walk.. 96
Bicarinatus striatus (Planorbis) Baker ... 96
Bicarinatus unicarinatus (Planorbis) Hald. 96
Bicinctum (Pleurocera) Tryon 151
Bifasciata (Goniobasis) Lea 155
Bigbyense (Pleurobema) Lea 172
Billingsi (Physa) Heron 108, 111
Billingsi (Planorbis) Lea 96, 102
Biloba (Epioblasma) Raf. 185, 186
Binneyana (Cincinnatia) Hann. 136
Binneyana (Physa) Ancey 108, 113
Binneyi (Bythinella) W. G. Binn. 148
Binneyi (Planorbis) Tryon 98, 104
Binneyi (Pomatiopsis) Tryon 148
Bitæniatum (Pleurocera) Con. 154
Blanda (Goniobasis) Lea 162
Blanda (Melania) Lea 162
Blandi (Physa) Lea 108
Boreale (Pisidium) West. 189
Borealis (Ampullaria) Val. 123
Borealis (Ancylus) Mse. 118
Borealis (Ferrissia) Mse. 118
Borealis (Planorbis) West. 100
Borealis (Lampsilis) Baker 183
Borealis (Lampsilis) Gray 181
Boykiniana (Goniobasis) Lea 155
Breve subellipticum (Pleurobema) Simp. 172, 173
Brevicula (Lampsilis) Call 181
Brevidens (Truncilla) Lea 186
Brevis (Io) Anth. 199
Brevispira (Physa) Lea 108
Brevissima (Bythinella) Pils. 137
Brevissima (Paludestrina) Pils. 137
Brownii (Amnicola) H. F. Carp. 147
Brownii (Lyogyrus) H. F. Carp. 147
Brownii (Valvata) H. F. Carp. 147
Buchanensis (Planorbis) Lea 98, 99
Bulbosa (Goniobasis) Lea 155, 159
Bulimnæa Hald. 6, 8
Bullata (Obliquaria) Raf. 168, 169
Bullella Simp. 62, 64
Burroughianus (Viviparus) Lea 126
Bursapastoris (Quadrula) B. H. Wr. 165
Bythinella Moq.-Tand. 136
Bythinia Leach 28, 132
Bythininæ Stimp. 27, 132

Cælata (Micromya) Con. 185
Cælatus (Unio) Con. 80
Cahawbensis (Rhodacmea) Walk. 122
Calcarius (Ancylus) DeKay 121
Calceola Sw. 178
Calceolus sciotincola (Unio) DeG. 178
Californica (Goniobasis) Cless. 155, 159
Californica (Gundlachia) Row. ...20, 119, 121
Californica (Hydrobia) Tryon 137
Californica (Melania) Cless. 155
Californica (Pomatiopsis) Pils. 148
Californicum (Pisidium) Newc. 189
Caliginosa (Ampullaria) Rve. 124
Calli (Valvata) Hann. 130
Callioglyptus (Planorbis) Van. 96, 101
Callina Hannibal 125
Calyculina Cless. 188
Campanulatus (Planorbis) Say 12, 94, 97
Campanulatus minor (Planorbis) Dkr. ... 97
Campanulatus rudentis (Planorbis) Dall 97, 101
Campanulatus smithii (Planorbis) Baker . 97
Campeloma Raf. 24, 25, 127
Canthyria Sw. 51, 52
Capax (Lampsilis) Green 181
Caperata (Lymnæa) Say 8
Cardium (Lampsilis) Raf. 184
Caribæus (Planorbis) d'Orb. 97
Carinata (Paludina) Val. 126
Carinatum (Pleurocera) Lea 151
Carinatum (Strephobasis) Lea 151
Carinatum (Trypanostoma) Lea 151
Carinatus (Neoplanorbis) Walk. 123
Carinifera (Physa) Ancey 103
Cariniferum (Gyrotoma) Anth. 163
Carinifex W. G. Binn. 14, 15, 106
Carltonii (Physa) Lea 108
Cariosa (Lampsilis) Say 181
Caroliniana (Cyclas) Bosc. 85
Carunculina Simp. 66, 76, 180, 183
Carus (Planorbis) P. and F. 97
Castaneum (Pleurocera) Lea 151
Castaneum (Trypanostoma) Lea 151
Castus mirus (Unio) DeG. 181
Cataracta (Anodonta) Say 57, 176
Catenaria (Goniobasis) Say 155
Catillus (Unio) Con. 166
Caurina (Ferrissia) J. G. Coop. 118

Caurina subalpina (Ferrissia) J. G. Coop. 118
Caurinus (Ancylus) J. G. Coop. 118
Caurinus subalpinus (Ancylus) J. G. Coop. 118
Centrevillensis (Planorbis) Tryon 97, 101
Cerea (Goniobasis) Lea 158
Ceriphasia Sw. 151
Chickasawhensis (Quadrula) Lea 166
Christyi (Segmentina) Dall 104
Cigenda (Goniobasis) Anth. 155
Cincinnatia Pils. 29, 136
Cincinnatiensis (Amnicola) Anth. 135, 136, 148
Cincinnatiensis (Cyclostoma) Lea 148
Cincinnatiensis (Paludina) Anth. 29
Cincinnatiensis (Pomatiopsis) Lea ...136, 148
Cinctum (Trypanostoma) Lea 151
Cinerella (Goniobasis) Lea 158
Cipangopaludina Hann. 126
Circincta (Goniobasis) Lea 158
Circulus (Obovaria) Lea 180
Circumlineata (Goniobasis) Tryon 156
Circumstriatus (Planorbis) Tryon 97, 102
Clappi (Clappia) Walk. 31, 146
Clappia Walk. 31, 146
Clarkei (Amnicola) Pils. 133
Clarkii (Strephobasis) Lea 149, 154
Clathrata (Goniobasis) Lea 156
Clathrata (Tryonia) Stimp. 29, 139
Clava (Unio) Lam. 50
Clavula (Goniobasis) Lea 156
Clavus (Pleurobema) Raf. 172
Clinchensis (Io) C. C. Ads. 199
Clintonensis (Ptychobranchus) Simp. 182
Coarctata (Melantho) W. G. Binn. 128
Coarctata (Paludina) Lea 128
Coarctatus (Planorbis) Sby. 97
Coccinea (Quadrula) Con. 166, 167
Cochliaris (Goniobasis) Lea 156
Cochliopa Stimp. 31, 141
Cognatus (Unio) Lea 70
Cokeria Marshall 83, 187
Columbiana (Fluminicola) Hemp. 141
Columbiensis (Goniobasis) Whiteaves 156
Columella (Lymnæa) Say 7
Comalensis (Amnicola) P. and F. 133
Comalensis (Goniobasis) Pils. 156
Comalensis fontinalis (Goniobasis)
P. and F. 157
Commutatus (Planorbis) Sby. 98
Complanata (Alasmodonta) Bar. 61
Complanatus (Unio) Dill. 174
Compressa (Lasmigona) Lea 177
Compressa (Symphynota) Lea 60, 177
Compressa lindus (Unio) DeG. 177
Compressissimus performosus (Unio) DeG. 179
Compressum (Pisidium) Pme. 200
Compressum limnicolum (Pisidium) Sterki 189
Compressum smithii (Pisidium) Sterki .. 189
Concestator (Lampsilis) Lea 182
Confragosa (Alasmodonta) Say 58
Congeria Bartsch 84
Coniformis (Physa) Tryon 107, 108
Connesaugaensis (Goniobasis) Lea 157
Conradi (Pleurobema) Van. 172
Conradicus (Unio) Lea 70
Consanguineus (Unio) DeG. 172
Constricta (Lampsilis) Con. 181
Constrictus (Somatogyrus) Walk. 143
Contectoides (Viviparus) W. G. Binn. 124, 125
Contectoides compactus (Viviparus) Pils. 125
Contectoides impolitus (Viviparus) Pils. 125
Contectus (Viviparus) Millet 124
Contigua (Goniobasis) Lea 157
Cooperi (Lymnæa) Hann. 94
Cooperi (Physa) Tryon 108
Cooperiana (Quadrula) Lea 166
Cooperianum (Musculium) Pme. 188
Cooperianum (Sphærium) Pme. 188
Coosaensis (Lioplax) Tryon 130
Coosaensis (Paludina) Lea 130
Coosaensis (Somatogyrus) Walk. 143
Coosaensis (Tulotoma) Lea 130
Coosaensis (Vivipara) W. G. Binn. 130
Cor (Pleurobema) Con. 172, 173
Cordata (Obovaria) Raf. 168
Cornea (Strephobasis) Lea 149
Cornea (Tellina) L. 86, 200
Corneocyclas Fer. 189, 200
Corneola Cless. 199
Corneum (Pleurocera) Lea 154
Corneum (Sphærium) L. 199
Corneum (Trypanostoma) Lea 151
Corneus (Planorbis) L. 94
Corolla (Melania) Gld. 30
Coronatus (Paludina) Pfr. 140
Coronatus (Potamopyrgus) Pfr. 30, 140
Corpulentus (Planorbis) Gould 104
Corpulentus (Planorbis) Say 98
Corrigata (Hydrobia) Frfld. 137
Corrigata (Paludestrina) Frfld. 137
Corrugata (Goniobasis) Lea 158
Costata (Amblema) Raf. 47, 168, 170, 171
Costata (Alasmidonta) Raf. 60
Costata (Physa) Newc. 16, 106
Costata (Symphynota) Raf. 200
Costatella Dall 16, 106
Costatus (Planorbis) D. and B. 98
Costulata (Goniobasis) Lea 158
Couperi (Goniobasis) Lea 155
Crandalli (Goniobasis) Pils. 157
Crandalli (Physa) Baker 109, 111
Crapulus (Unio) Lea 173
Crassa (Eurycœlon) Hald. 149
Crassa (Unio) Raf. 182
Crassidens (Unio) Lam. 52, 174
Crassilabris (Segmentina) Walk. 104
Crassilabris (Somatogyrus) Walk. 143
Crassula (Campeloma) Raf. 25
Crassus (Ancylus) Hald. 117
Crassus (Lanx) Hald. 117
Crassus (Somatogyrus) Walk. 143
Crenodonta Schlüter 171
Crista (Planorbis) L. 13, 94, 98
Cristata (Valvata) Müll. 27
Crocata (Physa) Lea 109
Crudum (Pleurobema) Lea 172
Cubensis (Physa) Pfr. 109
Cubicoides (Goniobasis) Anth. 159
Cultratus (Planorbis) d'Orb. 12, 98
Cumberlandia Ortmann 40, 41, 105
Cumberlandiensis (Goniobasis) Tryon 157

Cumberlandiensis (Goniobasis) Tryon ... 157
Cumingii (Lithoglyphus) Frfld. 142
Cuneata (Pleurobema) Raf. 172
Cuneatus (Gnathodon) Gray 88
Cupreonitens (Physa) Ckll. 109
Currieriana (Amnicola) Lea 143
Currierianum (Pleurocera) Lea 152
Currierianum (Trypanostoma) Lea 152
Currierianus (Somatogyrus) Lea 143
Curta (Lithasia) Lea 149
Curtatum (Trypanostoma) Lea 152
Curtisii (Truncilla) F. and U. 185
Curtum (Pleurocera) Hald. 153
Cyclocalyx Dall 200
Cygneus (Mytilus) L. 57
Cylindrica (Lithasia) Lea 150
Cylindrica (Physa) Newc. 110
Cylindrica (Quadrula) Say 166
Cylindraceum (Pleurocera) Lea 152
Cylindraceum (Trypanostoma) Lea 152
Cylindricus (Unio) Say 44
Cylindricus acrispatus (Unio) DeG. 166
Cylindricus propetypus (Unio) DeG. 166
Cymatocyclas Dall 200
Cyphya (Obliquaria) Raf. 171
Cyprogenia Ag. 65, 68, 179
Cyrena Lam. 85, 187
Cyrenastrum Bgt. 199
Cyrenella Desh. 88, 190
Cyrenellidæ 39, 88, 190
Cyrenidæ 39, 85, 187

Dalli (Amnicola) Call 142
Dalli (Lyogyrus) P. and B. 147
Decampii (Goniobasis) Lea 157
Decampii (Melantho) W. G. Binn. ..128, 129
Decipiens (Somatogyrus) Walk. 143
Decisa flava (Campeloma) Curr. 127
Decisa melanostoma (Campeloma) Curr. . 127
Decisum (Campeloma) Say 25, 127, 128
Declivis (Planorbis) Sby. 98
Declivis (Planorbis) Tate 105
Declivis (Segmentina) Tate 105
Decurambis Raf. 178
Deflectus (Planorbis) Say 98
Deflexus (Planorbis) Sby. 98
Deformis (Physa) Curr. 109, 110
Dehiscens orionopsis (Unio) DeG. 175
Depressa (Amnicola) Tryon 32
Depressa (Ampullaria) Say 124
Depressa (Obliquaria) Raf. 179
Depygis (Goniobasis) Say 36, 157
Deserta (Amnicola) Pils. 133
Deshayesiana (Goniobasis) Lea 158
Deviata (Truncilla) Anth. 185
Diaboli (Paludestrina) P. and F. 137
Diaphana (Ferrissia) Hald. 19, 120
Diaphana (Physa) Tryon 108
Diaphanus (Ancylus) Hald. 120
Digenæ Simp. 170
Dilatata (Unio) Raf. 175
Dilatatus (Planorbis) Gld. 98
Dilatatus pennsylvanicus (Planorbis) Pils. 99
Distinguenda (Physa) Tryon 108, 109
Dollabelloides (Pleurobema) Lea 173
Donaciformis (Cyrena) Sby. 187
Donaciformis (Plagiola) Lea 179
Donacopsis (Unio) DeG. 185
Dorbignyana (Physa) Lea 109, 110
Downieana (Goniobasis) Lea 155
Downiei (Anculosa) Lea 163
Draparnaldi (Planorbis) Shepp. 98
Draparnaudi (Planorbis) Shepp. 98
Draytonii (Goniobasis) Lea 159
Dreissensiidæ 39, 84
Dromas (Unio) Lea 68
Dromus Simp. 65, 68
Dupontiæ (Cyrenoidea) Joan. 88
Duryi (Planorbis) Weth. 99
Duryi intercalaris (Planorbis) Pils. 99
Dysnomia Ag. 80, 82, 186

Ebenus (Quadrula) Lea 167
Edentulus (Strophitus) Say 56, 176
Edentulus shæfferianus (Strophitus) Lea . 176
Edgarianum (Pleurobema) Lea 172
Effusa (Pompholyx) Lea 14, 105
Elatior (Ancylus) Anth. 122
Elatior (Rhodacmea) Anth. 122
Elegans (Amygdalonaias) Lea 70
Elegans (Plagiola) Lea 70, 179
Elegans elegantopsis (Unio) DeG. 179
Elegans magnelegans (Unio) DeG. 179
Elevatum (Pleurocera) Say 152
Elevatus (Planorbis) C. B. Ads. 98
Elimia H. and A. Ads. 149
Elliottii (Lioplax) Lea 129
Ellipsaria Raf. 177
Ellipsaria (Obliquaria) Raf. 179
Ellipsiformis (Lampsilis) Con. 181, 185
Ellipsis (Obovaria) Lea 180
Ellipsis (Unio) Lea 75
Elliptica (Physa) Lea .....
..... 106, 108, 109, 110, 112, 115
Elliptica minor (Physa) Crand. 110
Elliptica (Unio) Raf. 172
Elliptio Raf. 43, 51, 52
Elongata (Physa) Say 116
Elongata arctica (Physa) Cless. 116
Elongatina (Physa) Lewis 116
Emarginata (Amnicola) Kust. 136
Emarginata (Paludina) Kust. 136
Emeryensis (Goniobasis) Lea 157
Epioblasma Raf. 186
Errans (Cyclas) Lewis 189
Errans (Musculium) Lewis 189
Erythropoma (Fluminicola) Pils. 141
Estabrookianum (Pleurobema) Lea 172
Etowahensis (Goniobasis) Lea 155
Eucosmius (Planorbis) Bartsch 99
Eucosmius vaughani (Planorbis) Bartsch . 99
Eugraptus (Ancylus) Pils. 120
Eulamellibranchia 39, 165
Eupera Bgt. 85, 87
Eurycœlon Lea 34, 36, 149
Eurynia Raf. 66, 76, 77
Euthyneura 5, 93
Exacutus (Planorbis) Say 99
Exacutus rubellus (Planorbis) Sterki ... 102
Exacuous (Planorbis) Say 99

Exacuous megas (Planorbis) Dall 99
Excavata (Lampsilis) Lea 184
Excavatus (Somatogyrus) Walk. 144
Excentrica (Ferrissia) Mor. 120
Excentricus (Ancylus) Mor. 120
Excurata (Melania) Con. 153
Exigua (Melania) Con. 138
Exilis (Paludina) Anth. 129
Eximium (Pleurocera) Anth. 152

Fabalis (Micromya) Lea 185
Fabalis (Unio) Lea 78
Fabula (Margaritana) Lea 63
Fallaciosa (Lampsilis) Smith 181
Fasciata (Unio) Raf. 182
Fasciola (Lampsilis) Raf. 182
Fasciolaris (Obliquaria) Raf. 178, 179
Fassinans (Pleurobema) Lea 172, 173
Fassinans rhomboidea (Pleurobema) Simp. 172, 173
Febigeri (Physa) Lea 110
Fecunda (Melantho) Lewis 127, 128
Ferrissia Walker 18, 19, 118
Ferrissiinæ Walker 17, 18, 118
Ferruginea (Amnicola) Calk. 133, 134
Ferussaciana (Anodonta) Lea 57
Ferussaciana incertopsis (Anodonta) DeG. 177
Ferussacianus (Anodontoides) Lea 177
Filocinctus (Planorbis) P. and F. 96
Filosa (Rhodacmea) Con. 118, 122
Filosus (Acroloxus) Con. 122
Filosus (Ancylus) Con. 21, 122
Filosus (Ancylus) Walk. 122
Fisherola Hann. 17, 18, 118
Flava (Obliquaria) Raf. 169
Flexuosa (Obliquaria) Raf. 185
Flexuosa bullata (Obliquaria) Raf. 169
Floridana (Amnicola) Frfld. 133
Floridana convexa (Amnicola) Pils. 134
Floridana (Cyrena) Con. 187
Floridana (Cyrenella) Dall 88, 190
Floridana (Cyrenoidea) Dall 190
Floridense (Campeloma) Call 127, 128
Floridensis (Goniobasis) Rve. 155
Fluminicola Stimp. 31, 32, 141
Fluminina Clessin 200
Fluvialis (Fusus) Say 35, 149
Fluvialis (Io) Say 199
Foliata (Truncilla) Hild. 185, 186
Foliatus (Unio) Hild. 82
Foliopsis (Anodonta) DeG. 176
Fontanus (Planorbis) Light. 12, 94
Fontinalina Sterki 200
Fontinalis (Bulla) L. 16
Fontinalis (Lithoglyphus) Frfld. 144
Fontinalis (Paludina) Phil. 144, 145
Fontinalis (Physa) L. 106
Fontinalis (Pisidium) Pfr. 200
Forsheyi (Physa) Lea 110, 116
Fossarina Clessin 200
Fragilis (Ancylus) Tryon 20
Fragilis (Ferrissia) Tryon 118, 119
Fragilis (Lasmonos) Raf. 180, 182
Fragilis (Physa) Migh. 110
Fragilis (Unio) Raf. 80, 182
Fraterna (Goniobasis) Lea 158
Friersoni (Quadrula) B. H. Wr. 167
Fusca (Ferrissia) C. B. Ads. 120
Fusca eugrapta (Ferrissia) Pils. 120
Fusca (Fluminicola) Hald. 141
Fusca minor (Fluminicola) Stearns 141
Fuscatus (Unio) Lea 175
Fusconaia Simp. 42, 48, 171
Fuscus (Ancylus) C. B. Ads. 19, 120
Fuscus eugraptus (Ancylus) Walk. 120

Galba Schrenk. 6, 8
Gastropoda 5
Gaudichaudii (Littoridina) Soul. 30
Geniculata (Anculosa) Hald. 149
Geniculata (Lithasia) Hald. 35
Geniculum (Campeloma) Con. 127
Georgiana altior (Vivipara) Pils. 125
Georgiana fasciata (Vivipara) Tryon 125
Georgiana limnothauma (Vivipara) Pils. . 125
Georgianus (Somatogyrus) Walk. 144
Georgianus (Viviparus) Lea 125
Georgianus altior (Viviparus) Pils. 125
Georgianus fasciatus (Viviparus) Tryon .. 125
Georgianus limnothaumus (Viviparus) Pils. 125
Gesneri (Goniobasis) Lea 158
Gibba (Melantho) Curr. 129
Gibbosa (Amblema) Raf. 186
Gibbosus (Unio) Bar. 175
Giganteus (Unio) Bar. 167
Gillia Stimp. 31, 32, 146
Glabra (Physa) DeKay 116
Glabratus (Planorbis) Say 99, 101, 103
Glandulum (Pleurocera) Anth. 152, 154
Glans (Carunculina) Lea 180, 181
Glauca (Goniobasis) Anth. 158
Glebula Con. 65, 70
Globosa (Ampullaria) Sw. 124
Gonidea Con. 42, 54, 175
Goniobasis Lea 34, 36, 149, 154
Gouldiana (Goniobasis) Lea 158
Gracilentus (Planorbis) Gld. 100
Gracilis (Lampsilis) Bar. 182
Gracilis (Unio) Bar. 73, 180
Gradatum (Pleurocera) Anth. 152
Grana (Paludina) Say 147
Granatoides (Goniobasis) Lea 158
Grandis (Anodonta) Say 176
Granum (Amnicola) W. G. Binn. 147
Granum (Lyogyrus) Say 147
Grosvernori (Physa) Lea 108, 110, 113
Gundlachia Pfr. 18, 19, 20, 121
Gwatkiniana (Rhodacmea) Walk. 122
Gyraulus Agassiz 10, 12, 94
Gyrina (Physa) Say 16, 106, 110,111, 112, 113, 114, 115
Gyrotoma Shutt. 34, 37, 149, 162

Haldemani (Ancylus) Bgt. 119
Haldemani (Ferrissia) Bgt. 119
Haldemani (Lymnæa) W. G. Binn. 8
Haldemani (Planorbis) C. B. Ads. 102
Haldemani (Planorbis) Dkr. 102
Haldemaniana (Vivipara) "Shutt." Frfld. 125
Haldemanianus (Viviparus) "Shutt." Frfld. 125

Haldemanina Dall 105
Haleanus (Viviparus) Lea 125
Halei (Physa) Lea 111
Hallenbeckii (Goniobasis) Lea 155
Harni (Planorbis) Pils. 102
Harperi (Amnicola) Dall 134
Harpethensis (Anculosa) Pils. 163
Hartmaniana (Strephobasis) Lea 154
Hatcheri (Littoridina) Pils. 30
Hauffenia Poll 33, 147
Havanensis (Planorbis) Pfr. 100
Havanensis (Segmentina) Pils. 100
Hawnii (Physa) Lea 110, 111
Heathella Hannibal 141
Helisoma Sw. 10, 11, 94
Hemilastena Simp. 178
Hemisphærica (Ferrissia) Walk. 120
Hemisphæricus (Ancylus) Walk. 120
Hemistena Raf. 175
Hemphilli (Bythinella) Pils. 137
Hemphilli (Paludestrina) Pils. 137
Hendersoni (Ancylus) Walk. 119
Hendersoni (Ferrissia) Walk. 119
Hendersoni (Somatogyrus) Walk. 144
Henslowianum (Pisidium) Shepp. 200
Heros (Natica) Say 123
Heros (Quadrula) Say 167
Heros (Unio) Say 46, 171
Hesione d'Orb. 174
Heterodon (Unio) Lea 63, 178
Heterostropha (Physa) Say .....
..... 16, 107, 108, 109, 111, 113
Heterostropha alba (Physa) Crand. ..111, 115
Heterostropha peninsulæ (Physa) Pils. .. 109
Hildrethiana (Physa) Lea 110, 113
Hinkleyi (Ancylus) Walk. 122
Hinkleyi (Gundlachia) Walk. 20
Hinkleyi (Pomatiopsis) Pils. 148
Hinkleyi (Rhodacmea) Walk. 122
Hinkleyi (Somatogyrus) Walk. 144
Hippeutis Agassiz 10, 12, 94
Hippopæus (Unio) Lea 168
Hirsutus (Planorbis) Gld. 13, 98, 100
Hirsutus borealis (Planorbis) West. 100
Hjalmarsoni (Gundlachia) Pfr. 121
Holstonia (Margaritana) Lea 61, 177
Horatia Bgt. 33, 147
Hordacea (Aplexa) Lea 116
Hordacea (Physa) Lea 116
Horni (Planorbis) Tryon 100, 104
Humeralis californica (Valvata) Pils. 130
Humerosa (Physa) Gld. 16, 109, 111, 115
Humerosus (Somatogyrus) Walk. 144
Humilis (Lymnæa) Say 9
Hypnorum (Aplexa) L. 114, 116
Hypnorum arctica (Aplexa) Cless. 116
Hypnorum glabra (Aplexa) DeKay 116
Hypnorum tryoni (Aplexa) Curr. 116
Hypnorum (Bulla) L. 16

Idahoense (Pisidium) Roper 200
Idiopoma Pils. 126
Imbecillis (Anodonta) Say 176
Imitator (Paludestrina) Pils. 138
Imperitus (Unio) DeG. 179
Incrassata (Paludina) Lea 128
Indianensis (Goniobasis) Pils. 158
Inosculata (Goniobasis) Tryon 159
Integer (Lithoglyphus) Frfld. 144
Integer (Somatogyrus) Say 144
Integra (Physa) Hald. 108, 111, 112
Integrum (Campeloma) Say 25, 127, 128
Integrum obesum (Campeloma) Lewis. 127, 128
Intensum (Pleurocera) Rve. 151
Intercalaris (Planorbis) Rhoads 99
Intermedia (Bythinella) Tryon 138
Intermedia (Pomatiopsis) Tryon 138
Intermedia (Quadrula) Con. 167
Interrupta (Obliquaria) Raf. 186
Intertextus (Planorbis) Sby. 100
Intertextus (Viviparus) Say 24, 125
Io Lea 34, 35, 149, 199
Iris (Eurynia) Lea 78
Iris (Lampsilis) Lea 182
Irrorata (Cyprogenia) Lea 179
Irroratus (Unio) Lea 69
Isogona (Melania) Say 145

Japonica (Paludina) Wood 126
Japonicus (Viviparus) Mts. 126
Jayanum (Musculium) Pme. 87
Jenksii (Planorbis) H. F. Carp. 100
Johnsoni (Amnicola) Pils. 134
Jugosus Simp. 199

Kincaidella Hann. 19, 20, 121
Kingii (Lymnæa) Meek 9
Kirklandi (Ancylus) Walk. 120
Kirklandi (Ferrissia) Walk. 120
Kirtlandiana (Quadrula) Lea 167
Klamathensis (Lanx) Hann. 18, 118
Klecakiana (Horatia) Bgt. 33
Knoxense (Pleurocera) Lea 200
Kootaniensis (Ancylus) Bd. 117
Kootaniensis (Lanx) Bd. 117

Labiatum (Pleurocera) Lea 151
Lachrymosa (Quadrula) Lea 167
Lachrymosus (Unio) Lea 44
Lachrymosa contraryensis (Quadrula) Utt. 167
Lacustrina Sterki 200
Lacustris (Nautilus) Light. 13
Lacustris (Tellina) Müll. 87
Lævapex Walk. 19, 120
Lævigata (Goniobasis) Lea 158
Lævigata (Melania) Lam. 158
Lamellibranchia 39, 165
Lampsilinæ Ort. 42, 64, 178
Lampsilis Raf. 66, 78, 180
Lanceolatus blandus (Unio) DeG. 179
Lancides (Fisherola) Hann. 18, 118
Lancinæ Hann. 17, 117
Lanx Cless. 17, 117
Lapidaria (Cyclostoma) Say 34
Lapidaria (Pomatiopsis) Say 143
Laqueata (Goniobasis) Say 158
Lasmigona Raf. 55, 59, 60, 177
Lasmonos Raf. 180, 182
Lastena Raf. 43, 53, 175
Lata (Anodonta) Raf. 54

Lata (Lastena) Raf. 175
Lata (Physa) Tryon 111
Lateralis (Obliquaria) Raf. 167
Latissima (Unio) Raf. 184
Lautus (Planorbis) H. and A. Ads. 104
Lawrencei (Goniobasis) Lea 158
Leana (Pompholyx) H. and A. Ads. 105
Leai (Goniobasis) Tryon 162
Leaii (Goniobasis) Brot 158
Lefevrei (Truncilla) Utt. 185
Lecythoides (Vivipara) Hann. 126
Lehnerti (Liogyrus) Ancey 147
Lehnerti (Lyogyrus) Ancey 147
Lemiox Raf. 66, 80, 185
Lens (Obovaria) Lea 180
Lens (Planorbis) Lea 98
Lenticulare (Sphærium) Sby. 188
Lenticularis (Planorbis) Sby. 101
Lenticularis (Pleurobema) Lea 171, 173
Lenticularis (Sphærium) Sby. 188
Lentus (Planorbis) Say 99, 101
Leptodea Raf. 180, 182
Leptodon (Lampsilis) Raf. 180, 182
Leptoxis Raf. 163
Lepyrium Dall 38, 164
Lesleyi (Pleurocera) Lea 152
Lesleyi (Trypanostoma) Lea 152
Letsoni (Amnicola) Walker 139
Letsoni (Pyrgulopsis) Walker 139
Leucophæatus (Mytilus) Con. 84
Levigata (Unio) Raf. 180
Lewisii (Campeloma) Walker 128
Lewisii (Gyrotoma) Lea 162
Lewisii (Pleurobema) Lea 171
Lewisii (Pleurocera) Lea 152
Lewisii (Schizostoma) Lea 162
Lewisii (Valvata) Curr. 131
Lewisii helicoidea (Valvata) Dall 131
Lexingtonia Ortmann 43, 51, 174
Liebmanni (Planorbis) Dkr. 94, 101, 102
Lienosa (Lampsilis) Con. 182
Ligamentina (Lampsilis) Lam. 182
Ligamentinus (Actinonaias) Lam. 75
Limnophila 5, 93
Limosa (Amnicola) Say 133, 134, 135, 136
Limosa (Paludina) Say 29
Limosa porata (Amnicola) Say 134
Limum (Campeloma) Anth. 127, 128, 129
Linearis (Paludina) Kust. 124
Lineata (Vivipara) Kust. 124, 125
Lineata (Vivipara) Val. 124, 126
Lineolata (Neritina) Lam. 164
Lineolata (Obliquaria) Raf. 179
Lioplax Hald. 24, 26, 129
Lithasia Hald. 34, 35, 149
Lithoglyphinæ Fischer 27, 30, 141
Littoridina Soul. 28, 30, 141
Loudonensis (Io) C. C. Ads. 199
Livescens (Goniobasis) Mke. 156, 157
Luteola (Lampsilis) Lam. 182
Lividus (Toxolasma) Raf. 180, 181
Longinqua (Amnicola) Gld. 138
Longinqua (Paludestrina) Gld. 138
Lordi (Physa) Bd. 107, 111
Lustrica (Amnicola) Hald. 148
Lustrica (Amnicola) Pils. 134
Lustrica (Paludina) Say 148
Lustrica (Pomatiopsis) W. G. Binn. 148
Luteocella (Goniobasis) Lea 159
Lymnæidæ 5, 93
Lymnæa Lam. 5, 6, 93
Lyogyrinæ Pils. 27, 33
Lyogyrus Gill 33
Lyonii (Goniobasis) Lea 158
Lyonii (Pleurobema) Lea 171
Lyonii (Pleurocera) Lea 152, 154
Lyonii (Strephobasis) Lea 154
Lyonii (Trypanostoma) Lea 152, 154
Lyttonensis (Io) C. C. Ads. 199

Maculatum (Pleurobema) Con. 172
Maculatus (Unio) Con. 172
Magnifica (Paludina) Con. 26
Magnifica (Tulotoma) Con. 130
Magnificus (Planorbis) Pils. 101
Magnum (Sphærium) Sterki 188
Malleata (Physa) Tryon 111, 113
Malleatus (Viviparus) Rve. 126
Margarita (Physa) Less. 112
Margaritifera (Mya) L. 40, 165
Margaritana Schm. 39, 40, 165
Margaritanidæ 39, 165
Marginata (Alasmodonta) Say 63, 178
Medionidus Simp. 65, 70
Medium (Cyclas) Sby. 188
Medium (Sphærium) Sby. 186
Meekiana (Gundlachia) Stimp. ...20, 119, 121
Megalonaias Utterback 42, 46, 167,171
Megaptera (Metaptera) Raf. 180
Megasoma (Lymnæa) Say 8
Megastropha Lea 106
Melantho W. G. Binn. 127
Meredithii (Pleurobema) Lea 171, 173
Menetus H. and A. Ads. 12, 94
Mergella (Valvata) West. 131
Merriami (Fluminicola) P. and B. ..141, 142
Meseschiza Lea 164
Metanevra (Quadrula) Raf. 44
Metaplata (Unio) Raf. 178
Mexicana (Physa) Phil. 113
Mexicana conoidea (Physa) F. and C. ... 112
Miamiensis (Ampullaria) Pils. 124
Micra (Horatia) P. and F. 33, 147
Micra (Valvata) P. and F. 147
Micra nugax (Horatia) P. and F. 148
Micra nugax (Valvata) P. and F. 148
Micrococcus (Amnicola) Pils. 134
Micromya Simp. 76, 78
Microstoma (Physa) Hald. 109
Milesii (Campeloma) Lea 127, 128
Milesii (Goniobasis) Lea 159
Miliaria (Amnicola) Parr. 134
Minor (Anculosa) Hink. 163
Minuta (Cingula) Tott. 138
Minuta (Paludestrina) Tott. 138
Minutissima (Fluminicola) Pils. 141, 142
Minutus (Turbo) Tott. 138
Mississippiensis (Pyrgulopsis) C. and P. . 140
Missouriensis (Amnicola) Pils. 134
Missouriensis (Pleurobema) Marsh 167

Modesta (Io) Lea 200
Modoci (Fluminicola) Hann. 142
Monas (Paludestrina) Pils. 138
Moniliferum (Trypanostoma) Lea 153
Monodonta (Margaritana) Say 165
Monodonta (Unio) Say 41
Monroensis (Bythinella) Dall 138, 141
Monroensis (Bythinella) Tryon 141
Monroensis (Hydrobia) Frfld. 141
Monroensis (Littoridina) Frfld. 30, 141
Monroensis (Paludestrina) Dall 138
Montanensis (Lymnæa) Baker 94
Moquinianum (Pisidium) Bgt. 87
Mühlfeldianus plurimaffinis (Unio) DeG. . 183
Multicarinata (Vivipara) Hald. 126
Multilineatus (Planorbis) Van. 102
Multivolvis (Planorbis) Case 97, 101
Murrayensis (Goniobasis) Lea 159
Musculium Link. 85, 87, 188
Mytiloides (Pleurobema) Raf. 172
Mytilopsis Con. 84

Nanus (Somatogyrus) Walk. 144
Napoideum (Pleurocera) Lea 152
Napoideum (Trypanostoma) Lea 152
Nathorsti (Planorbis) West. 101
Nautileus (Planorbis) Walk. 98
Nyadina DeG. 176
Nebulosa (Lampsilis) Con. 181, 182
Neglectum (Pleurocera) Anth. 151
Neomexicana (Amnicola) Pils. 135
Neoplanorbinæ Hann. 17, 22, 123
Neoplanorbis Pils. 22, 123
Neritidæ 37, 164
Neritina Lam. 38, 164
Nevadensis (Fluminicola) Walk. 142
Nevadensis (Pyrgula) Stearns 30, 139
Nevadensis (Pyrgulopsis) Stearns 139
Newberryi (Ancylus) Lea 17, 117
Newberryi minor (Carinifex) Coop. 105
Newberryi (Goniobasis) Lea 155
Newberryi (Lanx) Lea 117, 118
Newberryi (Planorbis) Lea 15
Niagarensis (Physa) Lea 112
Nicklinii (Physa) Lea 110, 112
Nickliniana (Paludestrina) Lea 29, 138
Nickliniana attenuata (Paludestrina) Hald. 138
Nigerrima (Lampsilis) Lea 182
Nigra (Unio) Raf. 174
Nigra maculata (Unio) Raf. 172
Nigrina (Goniobasis) Lea 155, 156, 159
Nobilis (Io) Lea 153
Nodosa (Io) Lea 153
Nodulata (Obliquaria) Raf. 168
Nolani (Vivipara) Tryon 128
Nolichuckyensis (Io) C. C. Ads. 199
Novangliæ (Ancylus) Walk. 119
Novangliæ (Ferrissia) Walk. 119
Noveboracense proclive (Pisidium) Sterki 189
Nuciforme (Pleurocera) Lea 152
Nuciforme (Trypanostoma) Lea 152
Nuttallii (Acroloxus) Hald. 117, 118
Nuttallii (Lanx) Hald. 117
Nuttallii (Physa) Lea 107, 108, 112
Nuttallii (Vellettia) Hald. 117
Nuttalliana (Amnicola) Frfld. 135, 146
Nuttalliana (Paludina) Lea 32

Obesa (Melantho) Lewis 128
Obesa (Paludina) W. G. Binn. 128
Obesa (Tritogonia) Simp. 170
Obesa (Vivipara) Tryon 128
Obesus (Melantho) Lewis 128
Obliqua (Quadrula) Lam. ..166, 167, 168, 169
Obliquaria Raf. 65, 67
Obliquata (Obliquaria) Raf. 186
Obliquus (Ancylus) Shimek 119
Obovalis (Obovaria) Raf. 167
Obovaria Raf. 66, 73, 74
Obovata (Lithasia) Say 35, 150
Obovata biconica (Lithasia) Pils. 150
Obrussa (Lymnæa) Say 9
Obscura (Ferrissia) Hald. 120
Obscurus (Ancylus) Hald. 120
Obstructa (Segmentina) Mor. 105
Obstructus (Planorbis) Mor. 105
Obtusa (Paludina) Lea 136
Obtusa (Valvata) Dr. 131
Obtusale (Pisidium) C. Pfr. 189, 200
Obtusus (Somatogyrus) Walk. 144
Occidentalis (Lampsilis) Con. 182
Occidentalis (Physa) Tryon 110, 112
Occidentalis (Planorbis) Coop. 101, 104
Ocmulgeensis dominus (Unio) DeG. 165
Ohioensis (Lastena) Raf. 176
Oleacea (Physa) Try. 110, 112
Olivacea (Amnicola) Pils. 135
Olivaceus (Planorbis) Spix 11, 94
Olivaria (Amblema) Raf. 180
Oneida (Amnicola) Pils. 135
Opercularis (Planorbis) Gld. 12, 94, 97, 101, 102
Opercularis multilineatus (Planorbis) Van. 101
Opercularis oregonensis (Planorbis) Van. 101
Opercularis planulatus (Planorbis) Coop.. 96
Orbiculata (Amnicola) Lea 134
Orbiculata (Lampsilis) Hild. 182
Orbiculus (Planorbis) Mor. 101, 102
Oregonensis (Ancylus) Cless. 121
Oregonensis (Planorbis) Tryon 102, 104
Ornata (Goniobasis) Lea 159
Osculans (Physa) Hald. 113
Osculata (Goniobasis) Lea 36, 154, 159
Ovalis (Ancylus) Mse. 119
Ovalis (Ferrissia) Mse. 119
Ovata (Lampsilis) Say 184
Ovatus (Unio) Say 79
Ovoidea (Gyrotoma) Shutt. 37
Ozarkensis (Fusconaia) Call 171, 172, 174
Ozarkensis (Goniobasis) Call 159
Ozarkensis (Lampsilis) Call 173, 183
Ozarkensis (Pyrgulopsis) Hink. 140

Pallens (Unio) Raf. 182
Pallescens (Unio) DeG. 181
Pallida (Amnicola) Hald. 134, 135
Pallidum (Pleurocera) Lea 151
Paludestrina d'Orbigny 28, 29, 136
Paludosa (Ampullaria) Say 23, 124
Palustris (Lymnæa) Müll. 9
Papillosa (Goniobasis) Anth. 155

Parallela (Ferrissia) Hald. 119
Parallelus (Ancylus) Hald. 119
Paraptera Ortmann 65, 72, 180
Parkeri (Physa) Curr. 111
Parkeri (Pleurocera) Tryon 200
Parkeri (Quadrula) Geiser 170
Parva (Amnicola) Lea 135
Parva (Amnicola) Marsh 135
Parva (Angitrema) Weth. 150
Parva (Lampsilis) Bar. 183
Parva (Lithasia) Weth. 150
Parva (Physa) Lea 113
Parvulus (Somatogyrus) Tryon 144
Parvus (Planorbis) Say 13, 94, 102, 104
Parvus walkeri (Planorbis) Van. 102
Parvus (Unio) Bar. 76, 180
Patelloides (Ancylus) Lea 117
Patelloides (Lanx) Lea 17, 117
Paulensis (Io) C. C. Ads. 199
Pectinibranchia 23, 123
Pegias Simp. 62, 63, 178
Peninsulae (Ancylus) P. and J. 121
Peninsulae (Ferrissia) P. and J. 121
Pennsylvanica (Goniobasis) Pils. 159
Pennsylvanicus (Somatogyrus) Walk. ... 145
Peracuta (Amnicola) P. and W. 136
Perdix (Lampsilis) Lea 183
Perfecta (Bythinia) Frfld. 132
Perforatus (Planorbis) Sby. 102
Perplexa (Truncilla) Lea 186
Perplicata quintardii (Quadrula) Cragin . 170
Perpurpurea (Lampsilis) Lea 183
Personatus (Unio) Say 83
Pertenuis (Unio) DeG. 183
Peruviana (Quadrula) Lam. 168
Perversa (Neritina) Gmel. 38
Phalena (Anodonta) DeG. 176
Phaseolus (Ptychobranchus) Hild. ...178, 179
Phaseolus (Unio) Hild. 67
Physa Drap. 15, 16, 106
Physemoda Raf. 200
Physidæ 5, 15, 106
Picta (Lampsilis) Lea 183
Pierosoma Dall 11, 94
Pilea Simp. 80, 82
Pilsbryi (Amnicola) Walk. 135
Pilsbryi (Lioplax) Walk. 129
Pilsbryanus (Somatogyrus) Walk. 145
Pinei (Ampullaria) Dall 124
Piscinalis (Valvata) Müll. 131
Pisidium C. Pfr. 85, 88, 189 200
Plagiola Raf. 65, 69, 179
Planorbella Hald. 10, 12, 94
Planorbidæ 5, 9, 94
Planorbina Hald. 11, 94
Planorbinæ H. and A. Ads. 9, 10, 94
Planorbis Müll. 10, 94
Planorbula Hald. 14, 104
Planulatus (Planorbis) Coop. 101, 102
Platynaias Walk. 59, 60, 177
Platypoda 23, 123
Pleasii (Lampsilis) Marsh 183
Plebeius (Goniobasis) Anth. 159
Plena (Melania) Anth. 36
Plena (Quadrula) Lea 167, 168
Plena (Strephobasis) Anth. 149, 152
Plenum (Pleurocera) Anth. 154
Plenus interduos (Unio) DeG. 169
Plethobasus Simp. 43, 49, 171
Pleuristriata marmocki (Goniobasis) Weth. 156
Pleuristriatus comalensis (Goniobasis) Pils. 156
Pleurobema Raf. 43, 50, 171
Pleurocera Raf. 34, 36, 149, 151
Pleuroceridæ 23, 35, 149
Pleuroceratidæ 149
Plexata (Planorbis) Ing. 102
Plicata (Lithasia) Weth. 150
Plicata (Quadrula) Say 168
Plicata-striata (Goniobasis) Weth. 160
Plicatula (Goniobasis) Lea 158
Plicatum (Pleurocera) Tryon 151
Plicifera (Goniobasis) Lea 160
Plicifera bulimoides (Goniobasis) Tryon . 160
Plicifera oregonensis (Goniobasis) Tryon 160
Pluristriata (Melania) Say 156
Politissima (Physa) Tryon 113, 115
Polymesoda Raf. 85, 187
Polyrhytis Meek 6, 9
Pomatiopsinæ Stimp. 27, 34, 148
Pomatiopsis Tryon 34, 148
Pomilia (Physa) Con. 113
Pompholyginæ Dall 14, 105
Pompholyx Lea 14, 105
Ponderosum coarctatum (Campeloma) Lea 128
Ponderosus (Bariosta) Raf. 170
Ponsonbyi (Carinifex) E. A. Sm. 106
Ponsonbyi (Planorbis) Sby. 106
Porrecta (Goniobasis) Lea 160
Potamopyrgus Stimp. 28, 30, 140
Powellensis (Io) C. C. Ads. 199
Præclarus (Ancylus) "Stimp." Lea 118
Præclarus (Lanx) "Stimp." Lea 118
Prærosa (Melania) Say 37
Pressodonta Simp. 62, 178
Primeana (Physa) Tryon 111, 113
Primella Coop. 188
Prolasmidonta Ort. 62, 63, 178
Propecælatus (Unio) DeG. 185
Propesulcatus (Unio) DeG. 186
Propeverutus (Unio) DeG. 175
Propinqua (Physa) Tryon 107, 113
Proptera Raf. 65, 71, 177, 180
Protea (Amnicola) Gld. 138
Protea (Bythinella) Stearns 138
Protea (Paludestrina) Gld. 138
Protea (Tryonia) W. G. Binn. 138
Protexta (Cyrena) Con. 187
Proxima (Goniobasis) Say 160
Pseudogalba Baker 9, 93
Pseudoön Simp. 73, 74
Pseudosuccinea Baker 6, 7
Pterosygna Raf. 59, 61
Ptychobranchus Simp. 65, 66, 178
Pudicum (Pleurobema) Lea 171, 173
Pulchella (Goniobasis) Lea 158
Pulla (Goniobasis) Lea 160
Pullatus majusculus (Unio) DeG. 174
Pullus (Unio) Lea 181
Pulmonata 5, 93
Pumila (Anculosa) Con. 145

Pumila (Ferrissia) Sterki 119
Pumilum (Pleurocera) Lea 152
Pumilum (Strephobasis) Lea 152
Pumilus (Anculotus) Con. 145
Pumilus (Ancylus) Sterki 119
Pumilus (Somatogyrus) Con. 145
Pupæformis (Goniobasis) Lea 160
Pupoidea (Valvata) Gld. 33
Purpurea (Lithasia) Lea 150
Pusilla (Cyclas) Gmel. 200
Pusilla (Obliquaria) Raf. 175
Pusillus (Unio) Lea 175
Pustulata (Quadrula) Lea 168
Pustulosa (Quadrula) Lea 168
Pustulosa pernodosa (Quadrula) Lea 168
Pygmaeus (Somatogyrus) Walk. 145
Pyramidata (Quadrula) Lea 167, 169
Pyrgulopsis C. and P. 28, 29, 139

Quadratus (Somatogyrus) Walk. 145
Quadrula Raf. 42, 43, 44, 166, 170
Quadrula (Obliquaria) Raf. 167

Radiata (Lampsilis) Gmel. 183
Radiata oneidensis (Lampsilis) Baker ... 183
Radix Mont. 6, 7
Rafinesquei (Unio) Van. 175
Rangia Desm. 88
Rangiana (Truncilla) Lea 83
Rangiidæ 39, 88
Rariplicata (Quadrula) Lam. 168, 170
Raveneliana (Alasmidonta) Lea 178
Raymondi (Musculium) Coop. 188
Reclivata (Neritina) Say 38, 164
Reclivata palmæ (Neritina) Dall 164
Recta (Io) Rve. 199
Recta (Lampsilis) Lam. 183
Recta (Unio) Lam. 77, 183
Recta latissima (Lampsilis) Raf. 184
Recta sageri (Lampsilis) Simp. 183
Reflexa (Obliquaria) Raf. 67
Refulgens (Quadrula) Lea 169
Retusa (Obliquaria) Raf. 168
Retusa (Obovaria) Lam. 180
Retusa (Unio) Lam. 74, 168
Rhipidoglossa 37
Rhodaceus (Ancylus) Hinkley 122
Rhodacme (Rhodacmea) Walk. 21, 122
Rhodacmea Walk. 21, 122
Rhodacmeinæ Walk. 17, 20, 122
Rhodocephala Walk. 21, 122
Rhomboidea (Physa) Crandall 109, 111
Rimosus (Unio) Raf. 80, 185
Riograndensis (Cochliopa) P. and F. ..31, 141
Rivalis (Physa) M. and R. 113
Rivalis (Physa) Shy. 113
Rivicolum (Sphærium) Leach 199
Rivulina Clessin 200
Rivularis (Ancylus) Say 19, 119
Rivularis (Ferrissia) Say 119
Roanense (Pleurocera) Lea 152, 153
Roanense (Trypanostoma) Lea 153
Robusta (Io) Lea 153
Robusta (Pomatiopsis) Walk. 148
Romæ (Goniobasis) Lea 161
Rorata (Melania) Rve. 153
Rosaceum (Musculium) Pme. 189
Rotundaria Raf. 43, 48, 170, 171
Rotundata (Ampullaria) Say 124
Rotundata (Unio) Lam. 71
Rowelli (Amnicola) Tryon 31
Rowelli (Cochliopa) Tryon 141
Rubellus (Planorbis) Sterki 102
Rubiginosa (Fusconaia) Lea 48
Rubiginosa (Quadrula) Lea 169
Rubra (Obliquaria) Raf. 169
Rudens (Goniobasis) Rve. 160
Rufescens (Goniobasis) Lea 161
Rufum (Campeloma) Hald. 127, 128
Rufum geniculiforme (Campeloma) Pils. . 129
Rufum gibbum (Campeloma) Curr. ..128, 129
Rufum meridionale (Campeloma) Pils. .. 129
Rugifera Simp. 62, 63, 178
Rugosa (Goniobasis) Lea 158
Rugosum (Sphærium) Shy. 188
Rugosus (Anodon) Sw. 176

Saffordii (Physa) Lea 114
Sageri (Unio) Con. 183
Salsa (Paludestrina) Pils. 139
Sampsoni (Planorbis) Ancey 103
Sanctijohannis (Amnicola) Pils. 135
Sapotalensis (Unio) Lea 75
Sargenti (Somatogyrus) Pils. 145
Sayana (Amnicola) Anth. 136, 148
Sayii (Physa) Tapp. 115
Sayunio DeG. 175
Scalariformis (Pyrgula) Wolf. 140
Scalariformis mississippiensis (Pyrgula) Pils. 140
Scalariformis (Pyrgulopsis) Wolf. 140
Scalaris (Ameria) Tryon 103
Scalaris (Paludina) Jay 103
Scalaris (Physa) Haldeman 103
Scalaris (Planorbis) Jay 103
Scalenaria Raf. 80, 81
Scalenia (Obliquaria) Raf. 172
Scarboroughi (Amnicola) Tryon 136
Schizostoma Lea 162
Scholtzi (Pisidium) Cless. 200
Schrokingeri (Amnicola) Frfld. 135
Scriptum (Alasmodon) Raf. 178
Securis (Plagiola) Lea 179
Securis (Unio) Lea 69
Seemanni (Hydrobia) Frld. 139
Seemanni (Bythinella) Pils. 139
Segmentina Flem. 10, 13, 104
Selecta (Quadrula) Wheeler 169
Seminalis (Fluminicola) Hds. 141, 142
Seminalis (Paludina) Hds. 142
Seminalis dalli (Fluminicola) Call 142
Shastensis (Goniobasis) Lea 160
Sheldoni (Amnicola) Pils. 140
Sheldoni (Pyrgulopsis) Pils. 140
Shimekii (Ancylus) Pils. 119
Shimekii (Ferrissia) Pils. 119
Shepardianus duttonianus (Unio) DeG... 182
Showalteri (Gyrotoma) Lea 163
Showalteri (Lepyrium) Lea 164
Showalteri cahawbensis (Lepyrium) Pils. . 164

Showalteri (Neritina) Lea 38, 164
Showalteri (Physa) Lea 113, 114
Showalteri (Schizostoma) Lea 163
Sibiricum (Pisidium) West. 189
Silicula (Goniobasis) Gld. 160
Similis (Goniobasis) Lea 161
Simpsonaias Fr. 178
Simpsoni (Lampsilis) Ferriss 184
Simpsoni (Pleurobema) Van. 173
Simpsonia Baker 93
Simpsoniconcha Fr. 55, 64, 178
Sincera danielsi (Valvata) Walk. 131
Sincera nylanderi (Valvata) Dall 131
Sincera utahensis (Valvata) Call 132
Singleyi (Eupera) Pils. 88
Sintoxia (Obliquaria) Raf. 169
Sinuata (Obliquaria) Raf. 175
Sinuosus (Planorbis) Bonnet 103
Smithii (Neoplanorbis) Walk. 123
Smithsoniana (Goniobasis) Lea 161
Smithsoniana (Physa) Lea 110, 114
Solenoides (Unio) Raf. 166
Solida (Lymnæa) Lea 93
Solida (Lymnæa) Phil. 93
Solida (Pompholyx) Dall 105
Solida (Quadrula) Lea 166
Solidum (Sphærium) Norm. 199
Somatogyrus Gill 31, 32, 142
Southalli (Cokeria) Marshall 84, 187
Sparsestriata (Physa) Tryon 110, 114
Sparus (Goniobasis) Lea 158
Sphæriastrum Bgt. 199
Sphærica (Quadrula) Lea 169
Sphæriidæ 39, 85, 188
Sphærium Scop. 85, 188, 199
Spillmani (Strephobasis) Lea 149, 154
Spillmani (Trypanostoma) Lea 153
Spillmanii (Campeloma) Lea 129
Spillmanii (Lioplax) Tryon 129
Spillmanii (Paludina) Lea 129
Spinosa (Io) Lea 35, 199
Spinosa (Pyrgulopsis) C. and P. 140
Spinosus (Potamopyrgus) C. and P. 140
Spinosus (Unio) Lea 52
Stagnalis (Lymnæa) L. 7
Stagnicola Leach 6, 9
Stagnalis appressa (Lymnæa) Say 7
Stagnicolum (Sphærium) Sby. 188
Stearnsiana (Goniobasis) Call 161
Stearnsiana (Paludestrina) Pils. 139
Stegaria (Obovaria) Raf. 179
Stelmophora (Vivipara) Stearns 126
Stewardsoni stevensoni (Unio) DeG. 186
Stimpsonia Cless. 136, 138
Stimpsoniana (Gundlachia) S. Sm. 121
Strengi (Somatogyrus) P. and W. 145
Strephobasis Lea 36, 149, 153
Streptoneura 23, 123
Striata (Obliquaria) Raf. 180
Striata (Physa) Lea 109
Striata (Valvata) Lewis 131
Striatus (Unio) Goldfuss 173
Striatus (Unio) Lea 173
Strophitus Raf. 55, 56, 176, 199
Subarata (Physa) Mke. 107
Subcarinata (Limnæa) Say 26
Subcrenatus (Planorbis) Cpr. 100, 104
Subcrenatus disjectus (Planorbis) Coop. . 103
Subcylindracea propexilis (Anodonta) DeG. 176
Subglobosa (Anculosa) Say 164
Subglobosa (Congeria) Partsch 84
Subglobosus (Somatogyrus) Say 144, 145
Sublirata (Goniobasis) Con. 155
Submytilacea 39, 165
Suborbiculata (Anodonta) Say 176
Subplanus (Unio) Con. 51, 174
Subrhombica (Goniobasis) Lea 161
Subrobustum (Pleurocera) Lea 153
Subrobustum (Trypanostoma) Lea 153
Subrostrata (Lampsilis) Say 184
Subrotunda (Obliquaria) Raf. 180
Subrotunda (Physa) Sby. 114
Subrotunda (Quadrula) Lea 167, 169
Subrotunda leucogone (Fusconaia) Ort. .. 169
Subrotundus (Ancylus) Tryon 118
Subrotundus (Lanx) Tryon 117, 118
Subsolidum (Campeloma) Anth.
.....25, 127, 128, 129
Substriatus (Somatogyrus) Walk. 146
Subtentus (Ptychobranchus) Say 67, 179
Subteritus pulchreornatus (Unio) DeG. .. 179
Subulare (Pleurocera) Lea 151
Subviridis (Unio) Con. 177
Sulcata (Goniobasis) Lea 161
Sulcata (Truncilla) Raf. 186
Sulcatum (Sphærium) Lam. 86
Sulcatus (Unio) Lea 81
Sulcularia Raf. 177
Supinum (Pisidium) A. Schmidt 200
Symmetrica (Goniobasis) Hald. 160
Symphynota Lea 177
Symphynota Simp. 177

Tæniata (Anculosa) Con. 164
Tænioglossa 23, 123
Tantillus (Neoplanorbis) Pils. 22, 123
Tantillus (Planorbis) Hink. 123
Tappanianus (Unio) Lea 177
Tarda (Ferrissia) Say 120
Tardus (Ancylus) Say 120
Tecomensis (Unio) DeG. 182
Tellicoensis (Pleurobema) Lea 171
Tellini (Horatia) Poll. 33
Tenebrosa (Goniobasis) Lea 162
Tenebrosa (Melania) Lea 162
Tenera (Lampsilis) "Rav." Mazyck 184
Tenerus (Lampsilis) "Rav." Mazyck 184
Tennesseensis (Somatogyrus) Walk. 146
Tentaculata (Bythinia) L. 132
Tentaculata (Helix) L. 28
Tenuis (Planorbis) Phil. 103
Tenuissima (Physa) Lea 114
Terebrale (Pleurocera) Lea 153
Terebrale (Trypanostoma) Lea 153
Teres (Unio) Raf. 181
Terrae-novae (Valvata) Fer. 131
Tetragenæ Simp. 170
Tetralasmus (Unio) Say 53
Texana (Hydrobia) Pils. 140
Texasensis (Unio) Lea 180

Theliderma Sw. 43, 44
Tintinnabulum (Anculosa) Lea 164
Tornhatoni duckensis (Unio) DeG. 173
Torquis Dall 13, 94
Torsa (Obovaria) Raf. 180
Torta (Melania) Lea 200
Tortum (Trypanostoma) Lea 200
Torulosa (Amblema) Raf. 186
Toxolasma Raf. 180
Trabalis (Lampsilis) Con. 184
Tractum (Pleurocera) Lea 151
Trapezoides (Amblema) Lea 47
Trapezoides (Quadrula) Lea 170, 174
Traskii (Physa) Lea 110, 114
Traskii (Planorbis) Lea 103
Triangularis (Unio) Bar. 186
Triangularis longuisculus (Unio) DeG. .. 186
Triangularis pergibbosa (Unio) DeG. 186
Tricarinata (Valvata) Say 27, 132
Tricarinata basalis (Valvata) Van. 132
Tricarinata confusa (Valvata) Walk. 132
Tricarinata infracarinata (Valvata) Van. 132
Tricarinata perconfusa (Valvata) Walk. . 132
Trigonus (Unio) Lea 48, 171
Triqueter (Truncilla) Raf. 81
Triquetra (Truncilla) Raf. 186
Triquetra triangularis (Truncilla) Bar. .. 186
Triticea (Physa) Lea 108, 113, 115
Tritogonia Agassiz 42, 45, 170
Tritogonia (Quadrula) Ort. 170
Trivolvis (Planorbis) Say ....
.... 11, 94, 98, 99, 100, 104
Trivolvis binneyi (Planorbis) Tryon 104
Troostiana (Physa) Lea 110, 115
Tropicorbis B. and P. 94, 101
Tropidina H. and A. Ads. 132
Tropidocyclas Dall 200
Trópodiscus Stein 10, 12, 94
Trothis (Somatogyrus) Doh. 146
Truncata (Truncilla) Raf. 179
Truncatula (Lymnæa) Müll. 8
Truncatum (Musculium) Lind. 87
Truncilla Raf. 66, 80, 81, 185
Tryoni (Anculosa) Lewis 164
Tryoni (Bulinus) Curr. 116
Tryonia Stimp. 28, 29, 139
Tuberculata (Obliquaria) Raf. 49, 171
Tuberculata (Rotundaria) Raf. 170
Tuberculata (Tritogonia) Bar. 170
Tuberculatus (Unio) Bar. 45
Tuberosus perlobatus (Unio) DeG. 167
Tulotoma Hald. 24, 26, 130
Tumens (Planorbis) Coop. 101, 104
Tumens (Planorbis) Pfr. 104
Tumidus (Planorbis) Pfr. 103
Tuomeyi (Unio) Lea 175
Turbiniformis (Amnicola) Tryon 142
Turrita (Io) Anth. 199

Umbilicata (Anculosa) Weth. 164
Umbilicatellus (Planorbis) Ckll. 104
Umbilicatus (Neoplanorbis) Walk. 123
Umbilicatus (Planorbis) Müll. 12, 94
Umbilicatus (Planorbis) Taylor 104
Umbilicatus (Somatogyrus) Walk. 146
Umbonatum (Eurycœlon) Lea 154
Unakensis (Io) C. C. Ads. 199
Undata (Quadrula) Bar. 169
Undata trigonoides (Fusconaia) "Fr." Utt. 170
Undulata (Amblema) Bar. 47
Undulata (Quadrula) Bar. 168, 170, 187
Undulata pilsbryi (Quadrula) Marsh 170
Undulata (Anodonta) Say 56, 176
Undulata (Goniobasis) Tryon 161
Undulata (Monodonta) Say 62
Undulatum (Pleurocera) Say 153
Unio Retz 174
Uniomerus Con. 43, 53
Unionidæ 39, 41, 165
Unioninæ Sw. 42, 166
Univittatum (Pleurocera) Lea 153
Univittatum (Trypanostoma) Lea 153
Urceus (Nerita) Müll. 23
Utahensis (Lymnæa) Call 9
Utahensis (Valvata) Call 132
Utterbacki (Pleurobema) Fr. 173, 174

Validus continuus (Unio) DeG. 169
Valvata Müll. 27, 130
Valvatidæ 23, 26, 130
Vanuxemensis (Lampsilis) Lea 184
Variabilis (Io) Lea 153
Ventricosa (Lampsilis) Bar. 184
Ventricosa cohongoronta (Lampsilis) Ort. 184
Ventricosa satura (Lampsilis) Lea 184
Venusta (Anodonta) DeG. 176
Venusta (Goniobasis) Lea 162
Venusta (Lampsilis) Lea 185
Venusta (Physa) Lea 115, 116
Venustum (Pleurocera) Lea 153
Venustum (Trypanostoma) Lea 153
Vermicularis (Planorbis) Gld. 104
Verrucosa (Angitrema) Raf. 164
Verrucosa (Io) Rve. 199
Verrucosa (Obliquaria) Raf. 170
Verrucosa (Pleurocera) Raf. 151
Versa (Goniobasis) Lea 162
Vibex (Lampsilis) Con. 184
Vinosa (Physa) Gld. 115
Violaceus (Unio) Speng. 174
Virens (Planorbis) C. B. Ads. 98
Virgata (Anculosa) Lea 164
Virgata (Physa) Gld. 109, 114, 115
Virginea (Physa) Gld. 115
Virgata alba (Physa) Ckll. 115
Virginica (Goniobasis) Gmel. 162
Virginica bilirata (Goniobasis) DeG. 162
Virginica (Tellina) Gmel. 200
Virginicum (Pisidium) Bgt. 88
Virginicus (Somatogyrus) Walk. 146
Viridis (Lasmigona) Raf. 177
Viridis (Symphynota) Simp. 177
Viridis (Unio) Raf. 177
Viridis fuscata (Unio) Raf. 177
Viridistriata (Goniobasis) Lea 162
Vivipara (Helix) L. 24
Viviparus Mont. 24, 124
Viviparidæ 23, 24, 124
Viviparus viviparus L. 126

Wabashensis (Pyrgulopsis) Hink. 140
Walkeri (Amnicola) Pils. 136
Walkeri (Ancylus) P. and F. 120
Walkeri (Ferrissia) P. and F. 120
Walkeri (Physa) Crand. 115
Walkeri (Truncilla) W. and C. 185
Walkeri (Viviparus) P. and J. 126
Walkerianus (Somatogyrus) Ald. 146
Walkerola Hann. 18, 118
Waltonii (Vivipara) Tryon 127
Waltonii (Viviparus) Tryon 125, 127
Wareanus (Viviparus) Shutt. 127
Warreniana (Physa) Lea 115
Wetherbyi (Gillia) Dall 135, 146
Wetherbyi (Hydrobia) Dall 146
Wheatleyi (Goniobasis) Lea 162
Wheatleyi (Gyrotoma) Lea 163
Wheatleyi (Lithasia) Lea 150
Wheatleyi (Planorbis) Lea 105
Wheatleyi (Pleurocera) Lea 153
Wheatleyi (Schizostoma) Lea 163
Wheatleyi (Segmentina) Lea 105
Wheatleyi (Trypanostoma) Lea 153
Wheeleri (Arkansia) O. and W. 59
Wheeleri (Somatogyrus) Walk. 146
Whitei (Physa) Lea 110, 116
Whitfieldensis (Goniobasis) Lea 162
Winkleyi (Amnicola) Pils. 135, 136
Wolfiana (Physa) Lea 116
Wrightianus (Strophitus) Walk. 199

Zig-zag illius (Unio) DeG. 179

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The Anculosae of the Alabama River Drainage

BY
CALVIN GOODRICH

Published in Co-operation with the Geological Survey of Alabama

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

THE ANCULOSAE OF THE ALABAMA RIVER DRAINAGE

By Calvin Goodrich

This study deals with a collection of Anculosae made by Mr. Herbert H. Smith within the drainage of the Alabama River between the years 1901 and 1918 for the Alabama Geological Survey. The new species, with one exception, were named by him. The classification follows that which he had in mind. After a year's examination of the collection, the writer feels toward Mr. Smith only the greatest respect for his industry in the field and the keenness of his observations. It was Mr. Smith's intention to prepare this paper himself. Death directed otherwise. His life spared, errors which possibly have crept into this paper would most certainly have been avoided.

The Anculosae vary exceedingly. They give the student the impression of an adaptive family that is constantly struggling with an altering environment. They are recommended to the scientist particularly as objects for tracing the geographical distribution of life in middle North America. I believe them to be no less valuable in this regard than the mammals, the crayfishes and the Naiades.

For help with this paper, the writer is indebted to Mrs. Daisy Smith, of the Alabama Museum of Natural History, who supplied a great deal of information about her husband's work and performed most of the thankless labor connected with handling the collection; to Miss Mina Winslow for the illustrations of the shells; to Dr. Bryant Walker for unwearying counsel.

The Group and its Environment

The Anculosae of the Alabama River system represent a distinct section of the genus. No species of Anculosa within the drainage occurs also outside of it. No species which is spoken of as an Atlantic, Ohio, a Cumberland or Tennessee form occurs within it.

The existence of this faunal cleavage was not suspected or was not believed in by Lea, Tryon and some of the other naturalists of their times. Lewis was convinced of it and laid emphasis on the fact as he glimpsed it. So far as can be learned from the literature his remarks passed unnoticed. It has remained, after many years, for Mr. Smith to demonstrate through his collections and studies that the dispersal of the Anculosae, however general it has been within the area of their habitat, has kept separate completely two main lines of development. This is the more remarkable because there has been an interchange of stream flow through piracy between the Tennessee tributaries and the Conasauga, and opportunities for the transfer of species, other than by means of stream capture, must have occured repeatedly farther to the west. A glance at the map will show that Wills Creek and Little River of the Coosa today very nearly touch Lookout Creek of the Tennessee. The latter is known to be inhabited by a typi-

cal Tennessee Anculosa. Branches of Black Warrior River, belonging to the Alabama system, and Flint Creek of the Tennessee, both having Anculosae, come within a little distance of each other. If the means of dispersal such as carriage by birds, mammals, wind, tornadoes and such floods as on a plateau bring streams of different drainage systems together—if such means were operative in the case of the Anculosae the forms of the Alabama and Tennessee rivers would long since have mingled. This study has made plain that intermingling has not taken place in recent geological time.

The manner of life of the Anculosae has undoubtedly had a great deal to do with restricting the means of distribution. I have not visited the Alabama streams and therefore cannot say with exactness just what are the habits of the genus there. It may be supposed, though, that these habits do not differ appreciably from those of the Anculosae of the Tennessee and Ohio systems. In the Clinch and Powell rivers of the Tennessee, the Anculosae are found on stones usually far from the shores and in the strongest current. The same thing is true of the two species at the Falls of the Ohio. After spring floods a fine coating of silt is left on the stones and in this medium the fresh water animal life leaves the chronicle of its movements as plainly as the marks of a pen upon paper Now while Pleurocera and Goniobasis are seen, for mollusks, to move about fairly actively, Anculosa moves scarcely at all. It seems to be content to find a place in the heavy current and to stay there, changing its position little except when change of water level or accident compels it.

There is not sufficient mud in such locations to serve as a carrier for mollusks on the legs of birds even if the mud present were of the kind to serve that end, which it isn't. As the eggs are laid in the same enviroment, being probably glued to stone surfaces, they too would be little likely to be carried away by birds. If the animal falls and is swept into still water the chances are against its surviving. Logs that might carry Anculosae down stream would come to rest as a rule in the quiet water rather than upon stones in swift water, and falling from such carriers must mean generally that the Anculosae perish. In the light of the record, the chances of such animals changing their habitat from one drainage into another when floods float logs across low land barriers seem exceedingly remote.

We must understand the dispersal of these creatures to be very slow, very restricted as to means and as being governed very largely by changes in the character of a stream—advantageous situations for the life of Anculosae arising and disappearing only over great periods of time.

The variability of the Pleuroceridae is notorious. Because of this, probably more than for any other one thing, the family has been neglected. Almost everyone who has had anything to do with it has hoped that as collecting became more extensive so many connecting links would be found that the number of species now recorded might be greatly reduced. Almost everyone has tried to avoid adding to the catalogue. One student, bold perhaps but more likely just impatient, did undertake a prodigious labor of lumping and he brought the number of species down to a meager dozen or so—deriving in the end, it must be feared, very little satisfaction for himself and certainly advancing the knowledge of systematic zoology not a

particle (Hannibal, 1912). As Mr. Smith saw it, and as I see it myself now, the undesirable conclusion is forced on one that there are far more existing species than have been described, that it may be a very long time before the last one has been found and the books closed.

The reason lies in the manner of life of the Pleuroceridae for one thing and for another in the apparent fact that the family is in the active ferment of evolution. The greater number of the species, in other genera as well as the Anculosae, inhabit rocks and gravel bars in swift-moving streams. The migrating impulse is absent. Observation leads to the conviction that in the case of a species of the Anculosa, as already mentioned, every moment of living may be spent upon a single spot of a single stone. Not only do the ordinarily recognized barriers restrict the spread of the animals, but the deep water of a river turns back creek forms, the deep water between bars in the same stream interrupts dispersal, in instances quite narrow rifts on a single group of shoals serve as effectual barriers.

The influences of isolation working from without thus exercise their greatest powers. Working from within the forces of evolution carry on differentiation still farther.

Speaking of one group of this family, Dr. Lewis (1873) made the despairing remark: "One cannot tell where to assign limits. Limits are apparently obliterated and species have no existence. They are a confused mass and must be referred to one type." I believe it is true that species in this family, except occasionally, do not exist as Dr. Lewis and his contemporaries wished to define the word species. One is lost who tries to think of these animals as having any such fixity of characters as occur in other families and orders. We have rather to think of the characters as overlapping from one race to another, even from genus to genus. That collection of individuals in the Pleuroceridae may be called a species whose predominant characters are not the predominant characters of another collection of individuals. If we see only a few specimens of a single species its own peculiar characters may often seem to be submerged by characters linking it with another species. But in a long series the individual characters stand out, and we are compelled then to recognize the existence of definable differences and to proceed to describe them and provide the label of a name. If we adopt the policy—the tempting course—of referring all these many collections to one or several types we surrender whatever value there is in the defining of local races and lose with it the means of tracing geographical distribution. Dr. Lewis' "confused mass" would become more confused than ever. All the tribes of American Indians—to go far afield for an analogy—are alike in certain regards, tribal characters overlap tribal characters, yet it is possible to differentiate tribe from tribe, and the right and necessity of the scientist and historian to speak of these collections of individuals as separate, distinct, differentiated, are not to be questioned.

With the method of evolution in this family, the writer is incompetent to deal. There has been so far no intensive study of the anatomy, no broad inquiry into the rules or rhythm of variation if any such things exist, no breeding and interbreeding to discover whether known rules of heredity apply here. It is a field still fallow for the experimenter.

THE GEOLOGICAL PROBLEM

In Cretaceous times, Georgia from Columbus northward and part of eastern and northern Alabama constituted a peneplain. The line westward from Columbus, Georgia, to Wetumpka and thence northwest through Centerville, Tuscaloosa and Fayetteville was the shore of the gulf which stretched as far as Cairo, Illinois, covered the western thirds of Tennessee and Kentucky, the greater part of Mississippi, part of Arkansas and the whole of what is now Louisiana. A stream of which the Coosa is now an existing part rose south or southeast of Chattanooga and emptied into the sea at or close to Wetumpka.

C. C. Adams describes the streams of the era in this region as in a condition of fine balance. In such a condition slight crustal changes might have brought about profound changes in stream course, diverting and rediverting flow, lending force to extensive piracies. A differentiated fauna necessarily experienced alterations with these changes. Parts of it were possibly left isolated, to retain characteristics, to intensify them or to lose them—all within itself. Other parts possibly suffered through competition or else interbred with forms of life with which hitherto they had not been in contact.

M. R. Campbell and C. W. Hayes, in 1894 and 1895, put forth the contention that as late as Tertiary times a river comprising the upper Tennessee and the Coosa flowed continuosly southward to the sea, and that—at some period in the Tertiary—a confluent of the Tennessee and one of the Sequatchie to the west formed a connection through Walden Ridge at Chattanooga and diverted the Tennessee section of the river into an entirely new course. D. W. Johnson reviewed this work ten years later. From studies upon the ground he came to a very decisive opinion that the "Tennessee River acquired its present course across the mountains some time before the close of the Cretaceous period when the present flat top of the mountains was continuous with the rest of the Cretaceous peneplain." To this view C. C. Adams was apparently won.

The theory of a Coosa-Tennessee River is not necessary to account for the dispersal of the Anculosae. Nor is it needed to explain the existing differentiation. A stream balance prevailing upon the Cretaceous peneplain such as Adams describes would permit of innumerable captures of tributaries and the transfer and dispersal of their molluscan species. Further there have been opportunities possibly in fairly recent times, geologically speaking, for an interchange of the fauna through stream piracy both to the east and the west of the mountains. Forms of Pleuroceridae in the Hiwassee, highly suggestive of Georgian forms, seem to point to captures by that stream from the Conasauga of the Coosa, the confinement of these forms to the Hiwassee and its vicinity pointing to a time of capture so recent that wide dispersal has not yet come about. There is reason, indeed, to believe that not only did the Hiwassee make captures from the Conasauga but that this latter stream also acquired tributaries which originally belonged to the present Tennessee confluent.

We are to imagine the Cahaba as a small stream in the Cretaceous times, flowing directly to the sea. The Black Warrior existed, if at all, either

as an extension of the Sequatchie River or as a small stream that now is a northern branch of the river. A question may be raised as to whether the valley containing both the Sequatchie and this northern reach of the Black Warrior ever was occupied by a single stream flowing its full length. It may be that in the Cretaceous the Tombigbee was not in existence at all. In every liklihood the Anculosae reached the three streams, Cahaba, Black Warrior and Tombigbee, from the Coosa River after the elevation of the continent and the linking of all these rivers with the Alabama.

CHARACTER OF ALABAMA STREAMS

The Coosa is said to have the most diversified molluscan life of any stream in the world. It has long been a classical collecting stream. Yet not until Mr. Smith undertook the labor was the collecting carried out in any systematic way. Concerning the reasons for the extensive animal population, Mr. Smith—so far as I can discover—has ventured to say nothing. But of the character of the Coosa and other Alabama streams, there occur many illuminating passages in his correspondence with Dr. Walker. Some of these are here printed in their chronological order.

From Wetumpka, he wrote toward the end of 1901:

"There is an island half a mile up the river, and we tried vainly to reach it for a long time, the water was too deep and swift. After awhile I managed to get a boat, and since then most of my collecting has been on the island. It is rocky and intersected by a number of small water channels, with numerous back-water pools. This island has turned out an astonishing number of species. Many of the forms are extremely rare and local. One pool is crowded with small species, some not over one-half inch, and it is about the only place in which I have found small ones at all."

Writing from Gadsden in October, 1904, Mr. Smith said:

"From Rome to Gadsden we found a constant succession of shoals, either along the shores or forming islands in the river. I think that the river shells are substantially the same down to the mouth of the Chattooga River. At first I thought there was a gradual change, but I found that a recurrence of the same conditions brought the same species. Below the Chattooga there are few shoals for ten or twelve miles; then a succession of rock and shingle shoals clear down to Gadsden; and on these we found a good many forms not seen above. I think, however, that this is only because the fauna gets richer; most of the species seen above persist as far as Gadsden."

In November of the same year he was at Riverside, writing:

"The Coosa below Gadsden is at first like the upper reaches. At the upper end of Minnesota Bend there are limestone rocks and shoals. Following this is a long stretch, eight or ten miles, in which the river is broad and lake-like with muddy bottom and low shores. I should think such reaches would be a pretty effectual bar to the migration of rock loving

Pleuroceridae, either up or down. Following this stretch come Leoto or Whistlenaut shoals, the first of the rock shoals which characterize the middle Coosa. These are really reefs of rocks extending quite across the river or leaving only a narrow channel. The river makes a strong current wherever it can find a passage. Two miles farther down and probably connected by rocks on the river bottom are the extensive Ten Island shoals. The Pleuroceridae show the greatest changes as we descend, that is, the changes are more apparent. The assemblage (upper Coosa forms) is continued as far as Minnesota Bend. Here on the limestone rocks there is a sudden and marked change. There is another marked change at the reef just above Leoto Shoals; and after that one or two new forms come in at every shoal."

In a letter of June 6, 1907, Mr. Smith gives a brief picture of collecting on the Weduska shoals:

"We could wade out half a mile in the rapids, which in that place are simply a succession of ledges with flat rocks or gravel between, the water swift in places, but never strong enough to be dangerous. I used to carry a large bag, and generally this and my pockets were filled in half an hour, though hardly one specimen in ten was saved."

Back in Wetumpka in February, 1908, Mr. Smith wrote:

"All this stretch (Cedar Island to Higgin's Ferry, Chilton County) is full of shoals except between Higgin's Ferry and Duncan's Riffle, where the water is still and deep. The distribution is exceedingly interesting. In very swift water we had to cling to rocks with one hand while fishing with the other for stones; once I got a dowsing."

Returned to University from Anita, he wrote of the Cahaba River:

"The Cahaba physically is very different from the Coosa. It is essentially a river of the Paleozoic limestone region, flowing through a gorge, and generally deep. The shoals, where they do occur, have deep water above and below. Stretches of deep water separate species of the Coosa, and apparently this is so of the Cahaba too."

Mr. Smith returned to the Middle Coosa in the summer of 1914. He says of Fort William shoals:

"Several reefs of rock cross the river diagonally, and on them we made our best hauls. It was exciting sometimes even for an old campaigner. There was one little pool under a fall which must have yielded over one hundred Gyrotomas. You would have laughed to see me sitting in the fall, holding on with one hand while I groped with the other, bringing up three or four every time; often they were washed out of my fingers, for the current was a caution. We worked until the last possible moment. When we left Fort William Shoals were entirely covered by the backwater of the power dam."

THE OPERCULA

The literature is singularly unhelpful regarding the opercula of the Pleuroceridae. After the first superficial examination, the earlier naturalists took it for granted, or they seem to have, that little or no variation existed in this character. Throughout the four hundred and more pages of Tyron's Monograph of the Strepomatidae (1873) are just two items in the text and two illustrations, one of them entirely unreferred to, which give any indication of a recognition of differences. Dr. W. D. Hartman (1871) mentioned the serrated operculum of *Anculosa foremani* Lea and the ribbon-like opercula of some specimens of *Leptoxis rubiginosa* Lea. Yet he generalizes about the operculum as if he were convinced that these two variants were but rare exceptions to a rule most firmly fixed. So keen an observer as Lewis apparently felt that the opercula were not worth the bother of examination though he was unorthodox toward the accepted facts of his day relating to species and their relationships. Not until Pilsbry, in describing *Goniobasis comalensis* (1906), pointed out a distinctive form of operculum did anyone hint that the organ might vary sufficiently to warrant intensive study.

From the beginning of his work in Alabama, Mr. Smith made a point of observing opercula. From his correspondence one gathers the information that he found them exceedingly helpful in separating puzzling forms of the family. In one instance, where the nodose Goniobases (Eurycaelon) and nodose Gyrotomae appear together in the Coosa River, the operculum constituted a definite demarkation of generic character more conspicious than a rudimentary Gyrotomic fissure. He had other experiences of the sort among species of Goniobasis in the Cahaba River. The two Anculosae, *formosa* and *foremani,* run very closely together in certain localities. The opercula permit immediate separation without uncertainty.

On December 6, 1905, Mr. Smith wrote to Dr. Walker: "*Goniobasis showalterii* Lea, as you know, has the operculum greatly prolonged. The species is common on some parts of Weduska, Peckerwood and Fort William shoals, and I noticed that when the snail has its foot out, the operculum curls over the body, lying on it very neatly. I have found the operculum of great service in separating species of Goniobasis, but it is necessary to use great care. No part of the mollusk is so subject to accidents and distortion as is the operculum. In fact I am practically sure some Pleuroceridae as well as Campeloma and Tulotoma may lose the operculum altogether and form another. I have found living and apparently healthy specimens without operculum, and I have found others with a tiny and almost transparent new-formed operculum in place of the normal large one."

The operculum sharply differentiates the species of the *picta* group from one another and also from all the other groups. This is true as well in regard to the line between *A. ligata* and other Anculosae. In the *compacta* group, the line is cleanly drawn as against other groups, but probably only the student of the genus would readily distinguish the variations of the opercula of the three species belonging to it. There is, on the other hand, a great deal of similarity among the opercula of the *taeniata, ampla* and *showalterii* groups, and this supports to some extent certain general similar-

ities in shell characters. In *A. flexuosa* H. H. Smith there are likenesses of shell which link the species both with the *picta* and the *taeniata* group. There is likewise a dimorphism of opercula.

In the *picta* group we have the largest opercula of the genus. They are all easily recognizable and separable apart from their shells, the spiral lines are usually well marked, there is a similarity of color and texture as there is a similarity in the fact that all have loosely-coiled whorls. The opercula of *picta* and *formosa* are alike in form, but the latter are large and the spiral lines are more clearly defined. From the Conasauga down to Cedar Bluff on the Coosa, the operculum of *dowiei* is more individual than it is farther south where it tends to mirror the operculum of *formosa*. As in the case of the shell, the operculum of *modesta* seems to be a degenerate form of *downiei*. The *foremani* operculum has the distinctive serrations first noticed by Hartman. It is inclined in many instances to be definitely triangular. Though in point of shell characters this species is closer to *formosa* than is *downiei,* the operculum yet points to a more distant relationship. Mr. Smith was at one time inclined to believe that his *clipeata* deserved erection as the type of a new genus upon the basis of the operculum, which is large, thick-margined, generally very dark and with the strong spiral lines near the center. It would seem that his opinion changed in this matter. The operculum of *clipeata* is carried at the very opening of the aperture, much as in the case of *Bythinia tentaculata* L.

The opercula of the *taeniata* group have tightly-coiled spiral lines, usually very indistinct. They are ovate to elliptical, ordinarily dark. In *taeniata* the opercula of young and half-grown specimens are usually elongate, but as the animal grows older it widens the organ. Those of *torrefacta* though generally rougher resemble the opercula of *taeniata* just as the shells are much alike. In *coosaensis,* the opercula are smaller, more regularly formed and less variable than in *taeniata*. The normal operculum of *griffithiana* is thick, dark, broader in proportion to altitude than in *taeniata,* the growth lines strong. The ribbon-like operculum which occurs in many specimens is a variant developing with the juveniles and there are no indications that it is brought about through accident or disease. The spiral lines and the nucleus are absent. Growth proceeds from the left margin, or that nearest the columella, along a straight line, turning outward slightly at the edges. As the ordinary operculum resembles a leaf, so in this kind of operculum the grain of a tree is suggested. Hartman (1871) was under the impression that such opercula occured among individuals inhabiting still water. Mr. Smith found it in *griffithiana* in numbers on the Coosa shoals. In *aldrichi* we find opercula of the normal and the produced form common to *griffithiana,* though much smaller. In *choccoloccoensis,* the operculum is shaped like that of *taeniata,* but the spiral lines are more loosely coiled. The operculum of *brevispira* is narrow, elliptical in the young, developing the characteristic *taeniata* form not until well grown. It may be described as the antithesis of the operculum of *clipeata,* for it occupies only one-third to one-half of the aperture, and when withdrawn must go far within the shell.

In the *ampla* group, the opercula are not easily to be distinguished from

those of the preceding group, and doubtless the affinities between the two groups is in general quite close. They have the closely-coiled inner whorls of the *taeniata* assemblage, are ovate to elongate, dark as a rule. In seeking an operculum of *ampla* to illustrate, none could be found among the river specimens which had any remaining traces of the spiral lines. The figure pictured is the operculum of a creek shell. Damaged and distorted opercula are the rule in this group. The *ampla* operculum is usually narrower in proportion to altitude than others of the group. In *mimica* the broad operculum illustrated is not wholly characteristic, elongate forms also appearing. The opercula of *plicata* are in general ovate, the growth lines frequent and strongly-marked. Those of *smithi* are closely related to the opercula of *plicata.*

No common characteristic is observable among the opercula of the *showalterii* group. *Showalterii* itself has a distinctive operculum, elliptical, dark, the margins of adult specimens thickened. The striking feature of the operculum of *sulcata* is the loosely-coiled spiral lines. Neither of these opercula does the operculum of *lirata* resemble, though in a longer series than has been at hand the connection might be made more clear. The operculum of *occultata* is like that of a small *sulcata.*

The opercula of the *compacta* group are small, thin, with tightly-coiled spiral lines when they appear at all. The organ to a large extent seems degenerate. The operculum of *compacta* which is illustrated has four whorls. This is probably an abnormality. The fan-like development of *melanoides* is characteristic also of the operculum of *vittata.*

The operculum of *ligata* is described in detail later on. There exists no close affinity to this form among the other Anculosae, nor is any relationship traceable to any kind of operculum so far discovered outside of the genus.

CLASSIFICATION

The Anculosae of the Alabama drainage divide into six groups, four of them well defined, two others which are not so distinctive and might prove upon more thorough study, particularly of the anatomy, to belong to one of the groups whose border lines are of satisfying clearness.

The *picta* group consists of six members, characterized by a similarity of shell structure and, to some extent, of opercula. Taking *picta* as the head of the group, not because it appears to be the most primitive form, but because it is the oldest in point of christening, *clipeata* and *formosa* are seen then to be the nearest relatives, with *foremani* more distantly connected and in shell characters allied to *formosa. Downici* can be fancied upon this family tree as the direct descendant of *formosa,* and *modesta* as the poor relation of *downiei.*

For a second group, *taeniata* has been taken as the leading term. The small and not very firmly established local race *torrefacta* is closely allied. Somewhat more distant is *coosaensis,* another local race, but which yet has acquired an unmistakable individuality and such prosperity as is indicated by large numbers. *Griffithiana* follows as a seemingly ancient offshoot. *Choccoloccoensis* would appear to be the descendant of *taeniata,* or of one of *taeniata's* antecedents, which invaded a tributary of the main

stream, becoming modified through isolation and the influences of creek conditions. *Brevispira* is still farther away from *taeniata,* presenting in part aspects common to *ampla* of another group and possessing a dimorphism peculiar to itself. *Aldrichi* I believe to be a derivative of *griffithiana* as also *flexuosa,* a puzzling form which supports the suspicion of hybridization more than any other species among the Alabama Anculosae.

The three members of the *compacta* group—*compacta, melanoides* and *vittata*—are small unsculptured mollusca, one living in Cahaba River, the second in the Black Warrior and the third in the Coosa. *Compacta* was recognized as a Lithasia by Tryon, but it is as truly an Anculosa as is *melanoides,* which it resembles. In shell characters the first two are alike, but as regards the opercula the affinities are closer between the second and third than between either of these and *compacta.*

Anthony's *ligata* constitutes a group to itself. It has no close relationships with any other living Anculosa and its operculum is unique.

The relationship of the members of the *ampla* group to one another is quite clear. *Mimica* is a creek form of *ampla,* confined to one stream so far as is known, which has become uniformly smaller, has intensified the parent sculpture and acquired a distinctive banding formula that involves more than 50 per cent of the collected shells. *Plicata* can be conceived as the living representative of emigrant *ampla* of long ago which went into the Black Warrior and the Tombigbee rivers. The small creek species *smithi* links with *plicata.* The whole group is compact, well characterized. Yet the gap between it and the *taeniata* group is vague. Conic forms of *ampla,* taken by themselves and lacking as they often do the flattened columella most strongly marked in juvenile and half-grown specimens, might easily be confused with *taeniata.* There is also a certain amount of resemblance in the opercula.

The *showalterii* group is less compact than the preceding one. Both *showalterii* and *sulcata* have smooth or nearly smooth forms, and seem then to belong to the *taeniata* group. Certain rather rare forms of *griffithiana* copy *lirata* and only because there exists a long gap in the river between the two races the species might justly be brought close together. The opercula are wanting in distinctiveness, resembling most those of the *taeniata* group. Yet the deeply sulcate character of the mass of these three species seems to warrant their separation into a group to themselves. They are besides common to one fairly short stretch of the Coosa River whereas the members of the *taeniata* clan are more widely scattered. *Occultata* is joined to this group on the ground of its *sulcata*-like operculum and the flaring peristome which is a well-marked feature of young *showalterii.* Mr. Smith also placed it here.

KNOWN DISTRIBUTION OF ALABAMA ANCULOSAE

PICTA GROUP

A. picta Conrad. Bars of Coosa River from below Wetumpka to Clairborne, Monroe County, on Alabama River.

A. formosa Lea. Coosa River, Minnesota Bend below Gadsden, Etowah County, to Wetumpka.

A. foremani Lea. Coosa River, Three Island Shoals, Talladega County, to Butting Ram Shoals, Coosa County.

A. clipeata H. H. Smith. Coosa River, below Riverside, St. Clair County, to Butting Ram Shoals.

A. downiei Lea. Conasauga River, Georgia, to about Riverside, on the Coosa.

A. modesta H. H. Smith. Coosa River, Cherokee and Etowah counties.

TAENIATA GROUP

A. taeniata Conrad. Coosa River, from northeastern corner St. Clair County, to Clairborne, Monroe County, Alabama River. Lower part of Cahaba River.

A. torrefacta H. H. Smith. Coosa River, Weduska Shoals.

A. coosaensis Lea. Coosa River, Fort William and Peckerwood shoals Talladega County.

A. griffithiana Lea. Coosa River, The Bar, Chilton County, to Wetumpka.

A. aldrichi H. H. Smith. Coosa River, near mouth Yellowleaf Creek, Chilton County.

A. flexuosa H. H. Smith. Coosa River, Wetumpka.

A. choccoloccoensis H. H. Smith. Choccolocco Creek, Talladega County.

A. brevispira H. H. Smith. Coosa River, Three Island Shoals, Talladega County, to Higgin's Ferry, Chilton County.

AMPLA GROUP

A. ampla Anth. Cahaba River, upper reaches to mouth; Coosa River, Wetumpka; creeks of Calhoun, St. Clair, Talladega, Shelby, Chilton and Coosa counties, tributaries to the Coosa.

A. mimica H. H. Smith. Little Cahaba Creek, Bibb County.

A. plicata Conrad. Black Warrior and Tombigbee rivers.

A. smithi Goodrich. Valley Creek, Jefferson County.

SHOWALTERII GROUP

A. showalterii Lea. Coosa River, Fort William and Peckerwood shoals, Talladega County.

A. lirata H. H. Smith. Coosa River, Three Island and Fort William shoals, Talladega County.

A. sulcata H. H. Smith. Coosa River, Ten Island Shoals, St. Clair County to Peckerwood Shoals, Talladega County.

A. occultata H. H. Smith. Coosa River, The Bar, Chilton County, to Butting Ram Shoals, Coosa County.

COMPACTA GROUP

A. compacta Anth. Cahaba River and tributaries.

A. melanoides Conrad. Black Warrior River and possibly Alabama River.

A. vittata Lea. Coosa River, The Bar, Chilton County, to Wetumpka.

LIGATA GROUP

A. ligata Anth.. Coosa River, Weduska Shoals, Shelby County, to Wetumpka.

Anculosa picta CONRAD

Figs. 6, 7

Anculosa picta Conrad, *Silliman's Journal*, Vol. ii, p. 342, pl. 1, fig. 15, Jan., 1934.
Anculosa zebra Anth., *Proc. Acad. Nat. Sci., Phil*, Feb., 1860, p. 69.

The species is described by Conrad from specimens he collected in the Alabama River at Clairborne, this material, according to Tryon, consisting of stunted or immature forms. Tryon probably had reference to a modification very common to the species in the Alabama River at Selma and less marked in the Coosa, occuring besides in at least one other member of this group. The normal *picta* is subglobose to conic, with areas almost flattened, having obscure nodules at the shoulders or in instances distinct nodules, the aperture large, ovate. In the case of the modification, the shell is decidedly narrow in relation to altitude, the whorl smooth and rounded, curiously compressed on the side close to the peristome, the aperture almost round.

The growth lines of *picta* are ordinarily fine, sometimes almost obliterated as if from the scouring by sand. Revolving striae are usually very faint and discontinuous, and often entirely absent. Folds, where they occur, are not very prominent. In one lot of Mr. Smith's own collecting from the Coosa at Wetumpka, 6 specimens had well-marked folds from suture to base, 3 had folds faint or nearly miscroscopic, 4 were without such markings; 6 had knobs or plicae at the shoulder, 7 were without such sculpture.

In color this species is usually a shining, light brown, varying to dark brown, sometimes greenish. The bands are fine, close-set lines of coloring matter, interrupted or continuous, varying in number from four or five to fifteen or sixteen. In several of the lots, the unbanded shells are equal in number to those with bands.

In half-grown specimens, the columella is strong, smoothly rounded, the deposit of callous at the top not particularly heavy. This character in old specimens shows a tendency to distortion; the columella becomes flattened on the outer edge and often is there eroded; the deposit of callous at the junction with the peristome is so large as to give an effect of buttressing peristome and columella. Of 27 shells in one lot from Wetumpka, the columella of all except one was white. A Cahaba River lot had 6 shells with white and 7 with reddish columella. White, purple and reddish columellae were noted in Alabama River shells. The peristome of *picta* is sharp-edged, firm, usually straight, sometimes curved near the suture.

The embryo shell is small, smooth, tightly coiled, the apex slightly raised. It consists of about one and one-half whorls. The adult *picta* may possibly acquire as many as six whorls.

The *zebra* forms of this species are unquestionably pathological. The coloring matter has been deposited in somewhat zigzag method longitudinally, four or five of these "blotches" occuring on the whorl. This irregularity in instances takes place in connection with the normal banding system. The abnormality has been noted in other species. Anthony's description and the remarks of Tryon lead to the assumption that *picta* was the shell before Anthony when he established the species *zebra*.

Measurements:

Altitude	*Diameter*	
19 mm.	11½ mm.	Coosa River, Wetumpka
18	11½	" " "
17½	12½	" " "
17	12½	" " "
18½	13	Cahaba River
18½	12	" "
17	12	" "
20½	13½	Alabama River
18½	12	" "
17½	11	" "
17½	11½	" " Selma
16½	10	" " "
15½	9½	" " "
13½	8¾	" " "
12	8	" " "

The operculum of *picta* is large, leaf-like, rather thin, reddish-brown, and consists of about three whorls. The left margin is thickened and usually straight, the apex acute, the right margin thin and frayed, the basal margin broadly rounded. The polar point is slightly sunken, the edges of the whorls within the operculum being sharply marked and raised though more so in some opercula than in others. The nucleus is well within the body of the operculum, slightly nearer the left than the right margin and situated about the lower third of the length. A "freak" operculum shows four well defined whorls. Growth lines are coarse.

Mr. Smith's Coosa River *picta* are labeled Wetumpka, but in a letter to Dr. Walker he has explained that the species was not taken in the true Wetumpka Shoals, but on gravel bars of the river below the town, a section geologically much younger. The other extreme of distribution, so far as known, is Clairborne.

Anculosa formosa Lea

Fig. 3

Anculosa formosa Lea, *Proc. Acad. Nat. Sci., Phila.*, 1860, p. 187; *Obs.* ix, p. 76, pl. 35, fig. 61.

Lea described specimens apparently of unusual rotundity and figured a juvenile individual. Tryon does not seem to have had access to a large

amount of material and was persuaded that Lea's *formosa* was synonymous with *A. ampla* Anth., a decision possibly justified under the circumstances. Mr. Smith was enabled to prove the specific identity of *formosa* from the shells in the Schowalter collection which did not come to the eyes of either Lea or Tryon. He himself collected a large series of these distinctive Anculosae. An adult from Fort William Shoals, Coosa River, is here described:

Shell: Conic, thick, Dresden brown, shining. It has ten or twelve low, broad, rather obscure folds from shoulder to base. At the shoulder are irregular nodules which in other shells often take the clear form of plicae. Microscopic lines of growth are fine; no revolving striae save the channels between the folds were observed. Suture impressed, irregular. Aperture ovate. A broad band appears at the top of the aperture and another at the base. Between these two bands are six or seven faint, interrupted fine lines of color such as occur in *A. picta* Con. Peristome sharp-edged, but firm; slightly curving near the suture. Columella porcelain white, very strong, curving regularly, rounded, flattened slightly on the outer edge, a heavy deposit of callous at the top, base unusually heavy. The shell is 19 mm. in altitude; diameter, 14¼ mm.; aperture, 8¾ mm. by 7. Collected by Herbert H. Smith, July, 1913.

The species first appears in the Coosa at Minnesota Bend, just below Gadsden. It has there many of the aspects of *A. downiei* Lea which occurs in the same shoals, being yellow or light brown, strongly folded and with distinct plicae. There is a gradual modification of these characters proceeding down the river. At Ten Island Shoals the shells tend to lose the plicae, to acquire a strongly shouldered appearance and to be slightly ligulate. The middle and lower river form begins to show at Three Island Shoals in Talladega County, though occasional mollusks above this locality have the middle river aspect. At Fort William Shoals plicated specimens are rather rare, smooth shells are more common than in the shoals above. The lots from Weduska Shoals, The Bar, Butting Ram Shoals and Wetumpka are smooth, without folds or clearly marked plicae.

Variations as to locality in the matter of banding are also noticeable. Minnesota Bend shells have fine lines within the aperture, often nearly obsolete, which follow the folds of the outer surface. At Ten Island Shoals a single shell was found which has three well marked bands of the usual form, one above the periphery, two below it. More and more shells of this character appear as the collections progress down the river. In one of the lots from Fort William Shoals, 44 have the fine, broken lines typical of *picta* with the addition of a heavy band at the base; 19 have the lines continuous together with the basal band; 20 have an arrangement of four equidistant, clearly defined bands. Five modifications of this latter arrangement were noted in a total of 28 specimens. In one lot from The Bar, nearly as many specimens had a few definite bands as had the many fine lines of color. The two forms were of equal number in material from Butting Ram Shoals.

The prevailing color of the columella of the up-river *formosa* is white. In a Fort William Shoals lot 85 shells had a white columella, 26 had the

columella purple, 4 were of red and 1 black. Below Peckerwood Shoals, which are an extension of those of Fort William, purple becomes the prevailing color of the columella, with the exception that the *formosa* taken by Mr. White at Wetumpka had the columella white.

In this species there occur specimens with a ground color of red, showing most richly in the columella. One shell from Fort William Shoals is black throughout, or a very dark purple. Material of the *flammata* coloration appears in lots from Hall's Island, Talladega County, down.

The embryo shell of *formosa* is smooth, tightly coiled, the apex slightly elevated. It consists of one and one half to one and three-quarters whorls. Probably an adult specimen, if uneroded, would show six whorls.

Two lots of shells in the Alabama collection, four specimens in all, are labeled as from the Cahaba and Alabama rivers. It is to be suspected that these are cases of mislabeling. Mr. Smith's collecting justifies the belief that Wetumpka is the southernmost point of distribution.

The operculum is thin, wing-like, dark-red. Left margin firm, nearly straight and slightly bent backward at the acute apex; right margin broadly curved, very much torn; basal margin rounded. Growth wrinkles very coarse. The nucleus is located in the lower third of the operculum about 1 mm. from the left margin. Whorls three. Spiral lines raised, not always well defined or regular. The area of attachment is elliptical, narrow relative to the size of the operculum. The operculum of *formosa* shows a close affinity to that of *picta*.

Measurements of Shells:

Altitude	*Diameter*	
17½ mm.	13 mm.	Below Minnesota Bend, Etowah County
19	13	Ten Island Shoals, St. Clair County
17½	13½	" " " " " "
16	12	" " " " " "
16½	12	Lonigan Shoals, " " "
18½	12¾	Clarence Shoals, " " "
18	13	Fomby Shoals, " " "
20	13½	Truss Shoals, " " "
18	14	Hall's Island, Talladega County
21	14½	Three Island Shoals, Talladega County
19	12	" " " " "
24	14	Ft. William Shoals, " "
20	13	" " " " "
19½	13½	" " " " "
16	12	" " " " "
14	11½	" " " " "
19½	14	Peckerwood Shoals, " "
19	13	Weduska Shoals, Shelby County
19½	14	The Bar, Chilton County
18	12½	" " " "
20	14	Butting Ram Shoals, Coosa County
19	13¼	" " " " "
15½	12	Wetumpka, Elmore County

Anculosa foremani Lea

Fig. 4, 5

Anculosa foremani Lea, *Proc. Amer. Phil. Soc.*, ii, p. 243, Dec. 1842.

In shell characters this species is closer to *A. picta* Con. than is *A. formosa* Lea. But while the operculum of *picta* and *formosa* are much alike, that of *foremani* is like the operculum of neither. The similarity of the shells of *formosa* and *foremani, picta* out of consideration, varies strangely with locality, the resemblances and differences seeming to play a game of see-saw as the collector travels down the Coosa River. At Three Island Shoals, for example, *foremani* is a smaller, smoother mollusk than *formosa,* without the basal band so oddly persistent in that species. At Fort William Shoals the two forms come so closely together that, lacking the opercula for guidance, a large series is required to make identification certain. At Weduska Shoals, the differences become more distinct again, *foremani* retaining folds, *formosa* having lost them, the fine lines of color of one being faint, those of the other strong. Thus with each locality there are variations permitting separation of the two species, yet not always because of the same characters. In general, *formosa* is a larger species, more shining, with slightly heavier columella and a greater tendency as it proceeds downstream to substitute a few bands of color for the many fine lines. If the hypothesis is correct that the animal, protected and less subject to environmental forces, is less inclined to change than the exposed shell of the mollusk then, with the opercula in mind, we may suppose that *foremani* sprang from a form distinct from the ancestral forms of *picta* and *formosa.* We must explain the marked resemblances of the shell as a case of convergent development.

The sculpture of *foremani* consists of fine growth lines, microscopic revolving striae being rather rare. About half of the specimens of any given lot have broad, flat folds, more or less distinct and about the same number have nodules at the shoulder which may be termed plicae.

The fine lines of color are usually interrupted and at places there are shells which, like *formosa,* acquire a band at the base in addition, though usually this character is not as strongly marked, when it exists, as in the other species. Bands first appear in material from Fort William Shoals, the arrangement being four bands with a fine line of color between two of them. Such specimens are comparatively rare and among *foremani* are noted only from the locality given, Peckerwood Shoals and Butting Ram Shoals. Shells having the pathological character of *flammata* and *zebra* are not uncommon to this species.

The color of the columella varies from white to red and purple. The collections from Three Islands Shoals have the columella white in four shells in six; at Butting Ram Shoals, virtually the southernmost point of distribution, purple columellae were to the white in about the same proportion.

The operculum is reddish brown with the edges transparent. It is nearly triangular in most instances and very small in proportion to the size of the

aperture. Growth lines coarse. The left margin is nearly straight, the right margin curved and serrated regularly, the base broadly rounded, serrated. The nucleus is sunken, the spiral lines loosely coiled, whorls three. The serrations begin at about one and one-half whorls, and usually can be observed even after the horny material of the operculum fills the interstices between them.

Measurements of shells:

Altitude	*Diameter*	
19½ mm.	13 mm.	Three Island Shoals, Talladega County
18	11½	" " " " "
21½	14½	Fort William Shoals, " "
20½	13½	" " " " "
19	14	" " " " "
18	12	" " " " "
18	14	Peckerwood Shoals, " "
20	13½	Weduska Shoals, Shelby County
18½	11½	" " " "
18	13	The Bar, Chilton County
20½	13¾	Near mouth Yellowleaf Creek, Chilton County
19½	14	" " " " " "
17	12½	" " " " " "
20½	13	Butting Ram Shoals, Coosa County

The species is confined to the Coosa River, appearing first at Three Island Shoals and reaching the limit of its distribution at Wetumpka, Mr. Smith's collection of *foremani* at this locality consisting of just one specimen. Judging by the numbers collected, the shallows near the mouth of Yellowleaf Creek, Chilton County, are the most flourishing places in the river for this most interesting form.

Anculosa clipeata H. H. Smith, new species

Fig. 8

Shell: Conic, of moderate thickness, body whorl slightly flattened; the base rounded. Growth lines fine, tending to wear smooth below the periphery; crossed in places just below the suture by a few discontinuous, waving striae. Apex eroded. Suture impressed. Three or four low nodules appear on the shoulder, marking where growth has been made over the deposit of shell material at the top of columella. Aperture ovate, yellowish white. Peristome sharp-edged, firm, curving outward just below the suture, a little sinuous toward the base. Columella pearl-white, rounded, a little flattened on the outer edge near the center, heavy at the top. The ground color of the epidermis is raw sienna of the Ridgeway color standards, with twelve interrupted lines of dark coloring matter, these showing up very sharply within the aperture.

Operculum: Oval, thick, leathery, measuring 6 mm. by 3½ mm. Apex acute. Left margin not so curved as the right margin, this margin being thickened, smooth-edged. The basal margin is broadly rounded. The nucleus is very small, slightly sunken, located about 1½ mm. from the left margin and in the lowermost third of the operculum. Whorls three.

Measurements of shell: Altitude, 15½ mm.; diameter, 11¼ mm. Aperture—altitude, 6¼ mm.; diameter, 5 mm.

Type locality: Coosa River, Fort William Shoals, Talladega County, Alabama. Collected by Herbert H. Smith, June, 1914.

Type in the Museum of Zoology, University of Michigan; paratypes in that museum and the Alabama Museum of Natural History.

This species has two distinct geographical forms. From the first locality at which it has been found—between Riverside and Ogletree Island in St Clair County—to Peckerwood Shoals, Talladega County, the species has some of the general characteristics of the *picta* group, being bright in color, rounded at the base, rather smooth and usually having fine, interrupted lines in place of bands. At Weduska Shoals a decided change is observed. The shell here is medal bronze to olive green in color. The base is sub-angular. Growth lines are raised, often rough. The arrangement of bands, where bands occur, is four—interrupted or continuous. The shell suggests a small *A. taeniata* Con. While no specimen of this latter form appears to have been collected above Weduska Shoals, occasional specimens of the middle river form have been found from Weduska Shoals to Butting Ram Shoals, apparently the southernmost point of distribution.

The sculpture of *clipeata* varies slightly, some specimens having the folds which are more or less common in this group and others showing a tendency to develop obscure plicae. In a lot from Fort William Shoals, 29 individuals had folds upon the surface, 90 were without any and about one shell in fifteen had indications of plicae. Folds and plicae were both generally absent in collecting from Weduska Shoals downward. Of 117 shells of one lot from Fort William Shoals, 100 had the characteristic fine lines; 15 had bands, the arrangement being four or a modification of it; two were without lines or bands. A lot from The Bar, Chilton County, had sixteen shells with the four-band formula, the bands broken or continuous, with three modifications of this arrangement, represented by one specimen each. Three shells lacked any bands, and none had lines. From where *clipeata* is first found to Peckerwood Shoals, the collumella is white with only occasional shells wherein this character was red or salmon. In the lower river forms, the salmon or salmon-orange columella is common to about as many mollusks as the white columella.

The embryo shell consists of about one and one-half whorls, smooth, loosely coiled and virtually upon the same plane. The adult *clipeata,* if uneroded, would probably be found to have five whorls.

The outstanding feature of this species is the extraordinarily large operculum. In specimens in which the opercula have not been removed they are seen to overlap the columella slightly, touching the edge of the outer lip and occupying practically the whole space of the aperture. Probably in life the operculum is not withdrawn more than one or two millimeters. Some unimportant variations have been observed. At Peckerwood Shoals, the operculum of the adult shell is thin and amber-brown as in the young. The basal margin seldom seems to suffer from abrasion as it does in opercula of many other species. The area of attachment, elliptical in shape, occupies about one-half of the operculum. Frequently the spiral lines seemed to be as strongly developed on the inner side as on the outer.

Measurements of shells:

Altitude	*Diameter*	
16 mm.	11½ mm.	Three Island Shoals, Talladega County
15½	11½	" " " " "
14½	10	" " " " "
20	12	Fort William Shoals, " "
17	11¾	" " " " "
16½	12	" " " " "
15½	11	" " " " "
16¼	11	Peckerwood Shoals, " "
14½	10	Weduska Shoals, Shelby County.
16¼	10¾	Near mouth Waxahatchee Creek, Shelby County
16½	11½	The Bar, Chilton County
15	10½	" " " "
14	10	Butting Ram Shoals, Coosa County

This species, so far as the records show, is confined to the Coosa River, reaches its maximum development at Fort William Shoals—judging by size and the quantity of material collected—and disappears with the end of Butting Ram Shoals.

Anculosa downiei Lea

Figs. 1, 2

Anculosa downiei Lea, *Proc. Acad. Nat. Sci., Phila.*, 1868, p. 153.

The highest place in the Coosa drainage at which Mr. Smith collected this species was in the Conasauga River, east of Dalton where the stream forms the border between the two Georgia counties of Whitfield and Murray. The one shell collected there, though apparently adult, was only 11 1-2 mm. in height by 8 mm. in diameter. Near Tilton, in the same river and about fifteen miles farther down, the largest shell was 10 1-2 by 7 1-2 mm. At his next station, Resaca, Gordon County, Ga., Mr. Smith's largest *downiei* measured 12 x 9 1-2 mm.

In the Oostanaula River, the continuation of the Conasauga, the shells have reached an extreme of 14 1-2 x 10 mm. At Rome, Ga., where the Oostanaula and the Etowah rivers join to form the Coosa, the largest shell has the measurements 15 x 10 mm. But up the Etowah at Kingston, about thirty miles above Rome, the size has again dwindled, the largest *downiei* collected being 12 x 5 1-2 mm.

This is an excellent illustration of a rule often recited that the size of fresh water mollusks frequently bears a ratio to the size of the body of water inhabited. The reasons seem clear. The upper reaches of a river are in the stage of a creek, being subjected to greater relative variations than the stream farther down. The waters become low in the dry seasons, warm, often stagnant, charged with the gases of vegetable decay. The soluble foreign material brought into the creek by brooks becomes more highly concentrated than in the true river. The Anculosae, which ordinarily move about very little, are forced into an unnatural energy as a measure of self-preservation. There are alterations in the quantity of food supplies, probably alterations in the quality of this food, certainly decided changes in the chemical constituents of the water. Circumstances dictate a smaller animal and therefore a smaller protective shell.

At Black Bluff on the Coosa River, a short distance below Rome, Mr. Smith's largest specimen of *downiei* measures 17 x 10 1-2 mm., at Cedar Bluff in Cherokee County, Alabama, the size has increased to 18 1-2 x 14 1-2 mm. This last is the largest lot collected by Mr. Smith and it seems to be indicated that here the species is most flourishing. In Terrapin Creek, the same county, conditions somewhat identical with those in Georgia again obtain. The average size of the adult shells is 14 x 9 1-2 mm., the maximum, 16 x 11 mm. Changes below this point are not great, yet are noticeable. At Fitz's Ferry, the largest *downiei* measures 16 1-2 x 11 1-2 mm., at Maple Grove, 14 x 10; near Slackland, Etowah County, 15 1-2 x 9 1-2; Lonigan Shoals, 14 x 11; Fomby Shoals, 15 x 11; Leoto Shoals, 16 x 11; Riverside, St. Clair County, 15 x 10 1-2. After Cedar Bluff, it would appear, the species tends to run out numerically, and this is accompanied by physical alterations.

The shells of any one colony of *downiei* show little of the extreme variability which marks the Pleuroceridae in general, maintaining about the same proportions of altitude to diameter from young to adult.

In typical specimens, the surface of the body whorl is covered with folds from suture to base. Below the periphery these ordinarily proceed regularly to the lip and are only occasionally wavy or wrinkled. Near the suture the folds are very much waved where they "pass over" the plicae. In the case of the up-river shells, the folds are narrow, sharply cut, but as one examines the shells proceeding downstream one notices that the folds become broad, smooth upon their surface, so nearly upon a plane that in poor light the shell to the eye seems smooth. At Coosa, Georgia, specimens appear which are very nearly smooth near the base and in the Cedar Bluff lots are several individuals of this character. Of thirty shells taken at Leoto Shoals, seven only have the typical folds; in the instance of twenty the folds are obsolete or nearly so below the periphery and three are entirely without folds. It is as if a characteristic wholly absent or rare in up-river forms had become the normal habit on Leoto Shoals. In almost every lot there are a few shells whose folds are broken into beads where the plicae are crossed. The "obscure, transverse revolving striae" of Lea's description are usually not continuous, being absent or faint upon the tops of the folds. Lea lays as much emphasis upon his shells being plicate as upon their being folded. But the plicae are not a constant character. They differ in size and in number. They are not always present. Study suggests that the plicae are caused by the massing of shell material at the top of the columellae during the rest periods and that individuals are governed by no fixed natural law as to the amount of the accumulation. When new growth begins, the secretion is in smaller quantity, and thus an effect is given of minature hills and valleys, and in as much as the "valleys" are often filled with dark coloring matter the plicae in such cases stand out conspicuously.

The color bands are in the texture of the shell as well as in the epidermis, being defined most clearly within the aperture. These bands consist of interrupted deposits of pigment, customarily laid within the folds though often "spilling over" into the creases between the folds. Sometimes the

color material is so irregularly secreted that deposits of it coalesce and the aperture is given a mottled effect. In only one shell of the collection, taken at Cedar Bluff, has there been so much secretion of pigment that the aperture is uniformly dark—indicating that what is more or less common among certain species of Goniobasis and Pleurocera is rare in *A. downiei.* Differences in color between shells from near the headwaters and those from mid-river or lower are slight. The unbanded shells are ordinarily a bright shining yellow, those thinly banded olive brown and the ones with heavy bands dark brown. In the Cedar Bluff collection shells for the first time appear that carry a great deal of pigment in the body material, being pinkish by transmitted light. Several more so distinquished were in the lots from Center Landing, the same county. At Fitz's Ferry, shells appear whose "body" color is deep red. Others were found to the point where *downiei* disappeared from the river. This coloration is not a case of bands coalescing, for bands may be distinguished against the background of red. The color includes the columella, usually a porcelain white, and the operculum, ordinarily maroon.

The embryo shell seems to be only one whorl in size, usually upon the same plane as in Planorbis, but not always. One young shell taken at Fitz's Ferry has two folds at the periphery of such size as to suggest the carina of young *A. praerosa* Say.

The operculum is thin, light red to maroon. Left margin thickened, slightly curved, the right margin ragged and broadly curved, the basal margin rounded. Growth lines coarse, widely spaced, spreading like an opening fan. The polar point is typically close to the left margin, though not on the edge. The spiral lines are well defined, loosely coiled, the whorls three. The smooth Leoto *downiei* have large opercula, the left margin straighter than usual, the whorls opening broadly. These opercula, together with shell characters, emphasize the relationship of the species with *formosa.* In general, the operculum of *downiei* is lighter of color than that of *formosa,* thinner, the spiral lines more cleanly cut. Also it is lighter than the operculum of *picta,* wider in proportion to length and it lacks the straight left margin, a pronounced character in *picta.* The spiral lines of *downiei* are clear to the naked eye. A magnifying glass is necessary to make out those of *picta.*

Anculosa modesta H. H. Smith, new species

Fig. 9

Shell: Conic, about twice as high as it is wide, having broad, flat, somewhat waving folds from suture to base of body whorl. Two or three low nodules suggest plicae nearly obsolete. Lines of growth delicate, regularly spaced. No revolving lines can be made out with a glass of moderate power. Color brown, shining. Two narrow bands becoming obsolete before the peristome is reached appear on the body whorl, one at the periphery, the other just above. No bands show in the ovate, bluish-white aperture. Apex eroded, only one whorl being entire. Suture not strongly impressed, a little waving near the peristome. Columella white, delicate, smooth, rounded, with only small deposits of callous top and base. Peristome thin, nearly straight, sharp-edged, a little broken.

Operculum: Very thin, reddish, 5 mm. in altitude, 3 mm. in diameter. Lines of growth fine, interrupted by occasional heavier lines which give the operculum the appearance of an opening fan when viewed by transmitted light. Left margin slightly curved, right margin broadly curved, thin and torn. Apex acute. Polar point, crater like, somewhat large for so small an operculum; it is located on the left margin about 1 mm. above the base. Spiral lines loosely coiled. About one and one-half whorls within the operculum can be traced. Area of attachment small, narrow, elongate.

Measurements of type: Altitude, 11 mm.; diameter, 7½ mm. Aperture—altitude, 6 mm.; diameter, 3½ mm.

Type locality: Coosa River, Riddle's Bend, Cherokee County, Alabama. Collected by Herbert H. Smith, October, 1904.

Type in the Museum of Zoology, University of Michigan. Paratypes in the Alabama Museum of Natural History.

This species is confined apparently to the Coosa River in Cherokee and Etowah counties, Alabama, above the middle river shoals. Mr. Smith's shells come from only three localities, rather close together. *Modesta,* to all seeming, is a small local race whose affinities are closest to *A. downiei* Lea. It differs from that species in being smaller, having weaker folds, less pronounced plicae, a greater tendency to vary. The bands are not so numerous. The operculum of *modesta* is much thinner and shows a more decided variability. The impression is given that in the case of this species the operculum has lost much of its usefulness as a protective organ.

Of 34 specimens from Riddle's Bend 1 has quite strong folds, 27 are moderately folded suture to base, in 4 the folds can be made out only with a glass and in the case of 2 shells there are no folds. No revolving striae were seen. The plicae consist mostly of flat nodules, irregular, seldom continuous in any one specimen.

The color varies from a shining yellow to light brown. The banding arrangement is four thin, continuous bands. Only one modification, other than that in the type, was noted, a single banded specimen lacking the basal band. Many shells have bands in the epidermis which do not show in the aperture. The number of specimens lacking bands exceed those with them.

The columella is usually porcelain white, sometimes cream-colored, uniformly regular and rounded. The variation in the peristome is exceedingly slight, this character being usually straight, sometimes a little curved near the suture.

The operculum is of the *picta-formosa-downiei* type, but is evidently degenerating and varies accordingly in size, form and scupture. Two opercula were observed to have curious little pits upon the anterior side as if diseased. This has not been remarked in the case of any other species.

Measurements:

Altitude	*Diameter*	
11½ mm.	7 mm.	Riddle's Bend, Cherokee County
11¼	7¼	" " " "
10¼	7	" " " "
9	6¾	" " " "
12	8	Below Minnesota Bend, Cherokee County
10	7	" " " " "
12	8	Fitz's Ferry, Etowah County
11¼	7½	" " " "
10½	7½	" " " "

Anculosa taeniata (Conrad)

Fig. 10

Anculotus taeniatus Conrad, *New Fresh Water Shells of U. S.*, p. 63, 1834.

This species has the longest range of any of the Anculosae of the Alabama system. Conrad described it from Clairborne, which is much nearer to the Gulf of Mexico than it is to the mouth of the Coosa River. Mr. Smith collected it as high on the Coosa as the northeastern point of St. Clair County and on all the big shoals below as far as Wetumpka. Material in the Schowalter collection is credited to the Cahaba River. It has been taken at Selma on the Alabama below the mouth of the Cahaba. Doubtless it could be found in favorable locations between this place and the type locality at Clairborne, and possibly beyond.

The variation in *taeniata,* while considerable, is not as confusing as that of several others of the species under consideration. There appear to be no more than a few clearly traceable offshoots. In form the species is heavy, subangular, usually shouldered or humped, often longitudinally produced. Lines of growth are very fine and close together. These are crossed, though not in the case of all shells, by revolving lines which are usually discontinuous and often undulate. Viewed under a glass this sculpture, when well marked, gives the surface of the shell the appearance of peach down. Shells with folds mostly confined to the shoulder appear in nearly all the lots, these being more common in material from the lower part of the Coosa than from the upper. Of 81 *taeniata* from Ten Island Shoals, St. Clair County, 64 were smooth, 17 had folds at the shoulder. Out of 74 from The Bar, Chilton County, the smooth shells numbered 56, those with folds 18. Yet there is actually no striking change in sculpture from the St. Clair County stations to Wetumpka.

The columella of *taeniata* is usually fairly stout, smooth, rounded, regularly developed and lacking the "buttressed" callous present in the equally large *A. formosa* Lea and *foremani* Lea. In old specimens of *taeniata* the face of the columella is sometimes ground down as if against the rocks, so as to give it the flattened appearance characteristic of some of the other species of Alabama Anculosae. Changes in the color of the columella from north to south were observed. Of 81 shells from Ten Island Shoals, 58 had the white columella, 5 were pink, 18 were streaked or spotted with purple or brown pigment. The columellae of the Truss Shoals shells were purple without exception. At the Three Island Shoals, the white columella became rare and at Ft. William Shoals one lot of 70 shells had only one specimen with a white columella. The columellae of Weduska Shoals material were purple or reddish while those of the shells from The Bar were all purple. The few shells from the Cahaba in the Schowalter collection had the white columella slightly touched with color. Fading in these specimens was marked.

The peristome of this species is ordinarily straight, sometimes slightly curved close to the suture; strong, sharp-edged.

The upper river shells are yellowish to olive-brown, the bands being well defined. Material from the lower part of the Coosa are much darker, less

shining, the bands more obscure. A mottled effect as in *flammata* and *zebra* mutations is rather rare, as is also the occasions when the coloring matter of the bands has spread throughout the shell.

Fifteen arrangements of bands were noted in this study—the arrangement of four equidistant bands prevailing. Nine arrangements were modifications of this formula, these being exceedingly uncommon and so indicating that they represent merely individual variation or aberration. Few shells without bands and few with the bands broken into squares or oblongs occur in the upper parts of this species' range. Below Lock 4, broken bands become predominant. In nearly every lot one to several shells occur which have bands upon the epidermis that do not show in the aperture.

The nuclear shell of *taeniata* is smooth, loosely-coiled, having about one and one-half whorls. Of seven juveniles from Ten Island Shoals, the columellae of six were white or pink and one was purple. All these shells were four-banded, the peristome flaring; no angulation occured at the periphery.

The operculum is elongate, reddish-brown, with growth lines fine to coarse, closely set together. The left margin is firm, very slightly rounded. Apex rounded. The right margin is thin, often broken and uneven, curved. The basal margin is broadly rounded, frequently worn or ragged. In ten opercula examined, the polar point of five was upon or close to the left margin. In the other half, it was nearly in the center of the basal margin. This shifting of position was due to wearing. The nucleus is very small, indented, crater-like. Such spiral development as can be made out in most of the opercula is closely confined to a very small space near the base, and in only one specimen examined was it possible to trace the full three whorls common to the operculum of species of this genus. The area of attachment is elongate, oval. In a small form of *taeniata* which Mr. Smith separated from collections at Ten Island, Three Island and Butting Ram shoals, the chief differentiation is an elongated, narrow operculum with a straight left margin.

Measurements of shells:

Altitude	*Diameter*	
17½ mm.	11 mm.	Clarence Shoals, St. Clair County
16	11	Lonigan " " " "
20½	14½	Ten Island Shoals, St. Clair County
18	12½	" " " " " "
15½	11½	" " " " " "
17	12	Lock 2, St. Clair County
16½	12	Truss Shoals, St. Clair County
16	10½	Three Island Shoals, Talladega County
20	13½	Ft. William Shoals, " "
20	13	Peckerwood Shoals, " "
19	13	Weduska Shoals, Shelby County
17½	12	" " " "
22	15	The Bar, Chilton County
21½	14½	" " " "
20	14½	" " " "
16½	11½	" " " "
16½	12	Wetumpka, Elmore County

Anculosa torrefacta H. H. Smith, new species

Fig. 11

Shell: Smaller than and not so heavy as the adult of *A. taeniata* Conrad, the species to which it is most closely related. It is subglobose, subangulated, slightly indented at the base. Lines of growth fine, close together, crossed by revolving striae, usually wavy and not always continuous. Just below the suture to within eight or ten millimetres of the peristome are low, broad nodules which are made to appear larger than they are by reason of spots of dark pigment between them, these nodules probably being the nearly obsolete remains of plicae. The type has no folds. The body color of the shell is red-brown, rather dull, looking as if burned. It is broken by four wide, continuous bands of purple. Apex eroded, the body whorl alone remaining. Suture irregular. Peristome sharp-edged, slightly sinuous, a little curved close to the suture. Columella smooth, regular, rounded, the callous not very heavy for a shell of this size; it is colored with purple, this being lighter at the base of the columella. Aperture ovate, reddish, marked with the four purple bands, one of which is lighter in tone than the others.

Operculum: Dark, reddish brown, thick; altitude 8 mm., diameter 4 mm.; the whole leaf-like. The left margin is nearly straight, the apex acute, the right margin firm, irregular; basal margin rounded. The polar point is small and at the base of the left margin. Area of attachment elongate, rounded at base, apex acute; bordered by a ridge of black callous.

Measurements of type: Altitude, 16 mm.; diameter, 12 mm. Aperture—altitude, 12 mm.; diameter, 7 mm.

Type locality: Coosa River, Weduska Shoals, Shelby County, Alabama. Herbert H. Smith, collector, August, 1913.

Type in the Museum of Zoology, University of Michigan; paratypes in that museum and in the Alabama Museum of Natural History.

This species is apparently confined to the Weduska Shoals. It represents an offshoot of *A. taeniata* and resembles to a degree the smooth forms of *A. griffithiana* Lea. Not all of the shells have the microscopic sculpture of the type, though it is common to most. Shells were found in the Smith collection the early whorls of which were decidedly plicate and one specimen bore two waving, narrow folds at the shoulder and dim, very flat folds on the base. A second specimen had widely spaced, nearly obsolete revolving lines like the channels between the ribs of sulcate Anculosae. Forms much constricted of body whorl were not uncommon.

On old shells, the columella is nearly always eroded at the umbilicus. Material with the columella white is rare; in banded shells this character is commonly purple, in unbanded specimens reddish. The curved peristome is present in all the ligulate shells, common though not pronounced in others. Specimens with straight lip are about one in four or five.

Four equidistant bands are the prevailing banding arrangement, these being usually broken into square or oblong markings. Shells with continuous bands as in the type are about one in six.

Torrefacta has a humped squat look and when numbers are laid out on a table they remind one of pictures of Indians sitting at council with blankets over their shoulders.

The operculum varies somewhat, the lines of growth being sometimes interupted by coarse lines representing the rest periods, the apex varying from acute to rounded, the left margin being as often curved slightly as straight. The right margin, particularly in young shells, is often torn, the

the basal margin usually so. The nucleus is small, pit like. The number of whorls is probably three. Such spiral lines as can be made out under the glass become lost in the material of the operculum after about one and one-quarter whorls.

Measurements of shells:

Altitude	*Diameter*	*Altitude*	*Diameter*
19½ mm.	13½ mm.	17 mm.	12½ mm.
18½	12½	16½	11½
18	13	15½	11¼
17½	12	15.	11

All are from Weduska Shoals.

Anculosa coosaensis Lea

Fig. 13

Anculosa coosaensis Lea, *Proc. Nat. Acad. Sci., Phila.,* March, 1861, p. 54.

This species, in Tryon's opinion, was the half-grown form of *A. taeniata* Conrad. Specimens of *coosaensis* in the Alabama collection show all the marks of maturity in the matter of shell deposit. The animal abandons its spire and confines its life to the body whorl, as in the mature of other forms. The shell experiences proportionally the same erosion. Tryon's decision, it may be, came about from the fact that certain specimens of *taeniata* taken by Dr. Schowalter in the Alabama River at Selma are so dwarfed as superficially to resemble Lea's species. A larger series of the true *coosaensis* than Tryon had before him would, in all likelihood, have prevented this mistake.

The species is apparently one of the most narrowly confined of the Anculosae. The explorations of Mr. Smith brought it to light only on the Fort William and the Peckerwood shoals of the Coosa River, the second group of shoals being not much more than an extension of the first. Because of this perhaps the variation in form is not great. Ordinarily the body whorl is flattened, but it is sometimes slightly constricted. Specimens occur which are subangulated, though typically the periphery is rounded. Numbers of the young are subglobose rather than conic.

Sculpture consists of fine to rough growth lines, crossed by striae which are sometimes but not always continuous, waving to straight. At times these revolving lines are more nearly to be described as raised than incised. A few shells were found with folds, also a few with sharp carinae as in the young of *A. praerosa* Say. The plicae when they appear are never more than flat, broad nodules with spots of dark coloring matter between them which brings them into prominence.

Color varies from yellow to dark brown, a few shells being reddish, a few green. Young shells are more apt to be greenish than older ones. The banding formula is usually four equidistant lines of color, continuous or broken. Of the eight arrangements of banding noted, seven were simple modifications of the prevailing system. Ninety-five shells in a Fort William Shoals lot were banded in epidermis and aperture, 6 in the epider-

mis only, 1 was without bands and 1 was streaked with color irregularly after the pattern of the shells known as *flammata*.

The columella of *coosaensis* is smooth, regularly developed, the larger callous at the top not particularly strong. As in the case of other species of this group, the outer edge of the columella is flattened near the umbilicus, being at right angles to the body whorl. This character is not always present or when present well marked. In color, the columella is purple or reddish, white being uncommon. In one lot, 87 had the columella purple, 16 with it slightly colored red or purple, 1 with this inner lip white. The peristome is straight or slightly curved near the suture.

The embryo shell seems to consist of about two small, smooth whorls, tightly coiled, sometimes elevated, sometimes on the same plane. Five or six whorls for the fully grown shell are indicated.

The operculum is elliptical or ovate, moderately heavy, light to dark red. Lines of growth are fine to coarse. In some opercula these lines are crossed at right angles by waving striae. Rest scars are not prominent or easily to be differentiated from growth lines. Apex usually rounded, sometimes acute. Curves of the margins unequal. The polar point is slightly raised, and normally is upon or near the left margin near the base. The whorls are three. The spiral development can seldom be made out; it is closely confined to the area near the polar point.

Measurements of shells:

Altitude	*Diameter*	
17½ mm.	9½ mm.	Coosa River, Schowalter collection
17	10	" " " "
16	10	" " Mohr "
15½	10½	Ft. William Shoals, Talladega County
15¼	9¾	" " " " "
14½	10	" " " " "
14	9	" " " " "
13½	10	" " " " "
13½	9	" " " " "
13	8½	" " " " "
11	8	" " " " "
11½	8	Peckerwood " " "

Anculosa griffithiana Lea

Fig. 15

Anculosa griffithiana Lea, *Proc. Amer. Phil. Soc.*, II, p. 83, July, 1841.
Anculosa rubiginosa Lea (?), *Proc. Amer. Phil. Soc.*, II, p. 83, July, 1841.

Following the example of Tryon, collectors and authors have usually given precedence to the name *rubiginosa*, a species described by Lea at the same time and upon the same page as *griffithiana*. The former species was, however, put down as a shell of "Warrior River", whereas the locality of the species under discussion here was given as the Coosa River. Only one character—"columella, thick, dark purple"—appears to point to the Coosa mollusk, while the rest of Dr. Lea's description of *rubiginosa* can apply to a smooth and fairly common form of *A. plicata* Conrad which does inhabit

the Black Warrior. Furthermore, occasional specimens of *plicata* have the "columella thick, dark purple". As against an argument that *rubiginosa* was not actually a Coosa shell it might be recited that Lea had the carelessness of his contemporaries in regard to type localities. But unless the one shell from which Lea described *rubiginosa* can be found and positively identified as his type, the uncertainty will remain. It seems best to employ the name *griffithiana,* and that this was Mr. Smith's belief is indicated by some of his labels.

The species has a narrow range. It occurs in great numbers at Wetumpka and it is from this place that most of the shells in the collections have come. Eight miles north, it is less flourishing—to judge from Mr. Smith's collections there. At Noble's Ferry in the same county, only one specimen of the species was taken by Mr. Smith. No locality is given for *griffithiana* above the northern line of Chilton County which by air line cannot exceed forty-five miles from Wetumpka. One lot of *griffithiana* from the Schowalter collection bears a Cahaba River label. These shells appear to be identical with Wetumpka material, and as Mr. Smith himself did not find the species in the Cahaba this may be considered an error on the part of Dr. Schowalter.

The shell as a rule is stoutly folded from suture to base, the folds being most pronounced in the Wetumpka shells. Smooth specimens or nearly smooth appear in all the lots, the greatest number coming from The Bar, Chilton County. In one lot from Wetumpka about one individual in eight is without folds. In another lot, one shell in four is without folds, one in eight has folds nearly obsolete. On the upper whorls of the shell are faint indications or remains of plicae. The fine growth lines are usually well defined, though upon some of the older specimens and on top of the folds of many others these lines have worn away. Microscopic revolving lines can be made out on most of the material. They show most plainly on shells devoid of folds.

Seven arrangements of the bands were noted in this study, the most common being four rather heavy, continuous, equidistant strata of coloring matter. Among Wetumpka shells, about twice as many unbanded specimens occur as banded. About one shell in twenty-eight has bands upon the epidermis which do not show in the aperture; about one in thirty-five has bands broken into squares as in the case of other species of this group. Among folded shells from The Bar which Mr. Smith separated from smooth forms, more banded than unbanded shells appear, the ratio of the one to the other being three to one.

The columella of *griffithiana* is rounded or angulated. It is usually stained with purple, red or pink coloring material. Shells with a white columella are rare. A characteristic of the species is that the columella covers the umbilical niche rather poorly. In some specimens a slight, eroded groove or hollow is left and in few specimens is the base covered completely and smoothly. The color of the shell ranges from yellow to dark brown, red shells are not uncommon and occasionally slightly mottled shells appear.

The peristome is very slightly curved near the suture, is sharp-edged and in heavily-folded shells it tends to be sulcate.

The nuclear whorls are tightly coiled, smooth and not upon the same plane, the embryo shell appearing to be one and one-fourth to one and one-half whorls in size. In one young and uneroded specimen the nuclear whorls are bright red, smooth, elevated; the second whorl dark green, slightly carinate, shining and smooth between the carinae; the third whorl angulated at the base, folded, having four interrupted bands. In another juvenile the second whorl has a slight beading at the top close to the suture, a spot of color occuring between nodes.

The operculum is dark red by transmitted light, about twice as long as wide. Lines of growth are pronounced, the margins thickened and usually smooth, the apex pointed though sometimes rounded. The polar point is at the edge of the left margin below the center. The operculum is usually "indented" at the polar point where the animal has rubbed the operculum against the columella. In instances, the basal margin has been worn away until the nucleus rests upon the base. The spiral lines in most of the opercula examined are very nearly obsolete. Three whorls are indicated, the first two very tightly coiled. Tryon illustrated a specimen of *griffithiana* with tongue-shaped operculum, but makes no mention of it in the text. Numbers of shells with opercula of this nature are in the Alabama collection. This form is described elsewhere.

A label in a tray of Wetumpka *griffithiana* reads: "On rocks in swift water less than 4 feet deep when the river is low."

Measurements of shells:

Altitude	*Diameter*	
20½ mm	11½ mm.	Wetumpka
18½	11	"
17	12	"
16	12	"
15½	10½	"
15	10	"
13	9	"
15	10	Eight miles above Wetumpka
13½	10	" " " "
11½	8½	Noble's Ferry, Elmore County
12	9½	Butting Ram Shoals, Coosa County
12	9	" " " " "
11½	8½	" " " " "
14	10	" " " " "
13	9½	" " " " "

Anculosa aldrichi H. H. Smith, new species

Fig. 16

Shell: Subglobose, smooth, shining, subangulate, the base somewhat flattened and indented. Color of epidermis light brown, crossed by four dark, discontinuous bands each about 1 mm. wide. Within the aperture these bands appear against a bluish-white background of shell material. Apex eroded, the body whorl alone remaining entire. Lines of growth fine, regularly spaced, interrupted by three rest-period scars which are rather narrow, two of them being raised above the surface of

the shell. The growth lines are crossed by very delicate, microscopic revolving striae, waving, broken, absent on some parts of the shell. Suture a little irregular. Aperture ovate. Columella moderately stout, rounded except on the outer edge at the center where it is flattened. Peristome sharp-edged, but firm, a little curved close to the suture.

Operculum: Dark, rather thick, lines of growth very fine, rest scars not heavy. Size 5 mm. by 3½ mm. Apex rounded. Curves of left and right margins nearly equal. The base of the operculum of the type is lighter colored and thinner than the rest of the operculum, indicating that it has been renewed after injury or wear. The polar point is small, very slightly raised above the plane of the operculum. It is on the left margin near the base. One and one-half whorls of the closely-coiled spiral development are traceable. The area of attachment is elliptical, the edges thickened with dark callous.

Measurements: Altitude, 13½ mm.; diameter, 10 mm. Aperture—altitude, 6½ mm.; diameter, 5 mm.

Type locality: Coosa River, near mouth of Yellowleaf Creek, Chilton County, Alabama. T. H. Aldrich, collector.

The type is in the Museum of Zoology, University of Michigan; paratypes in that museum and the Alabama Museum of Natural History.

This is a localized race, being apparently confined to one shoal of the Coosa River. It has the general appearance of *A. taeniata* Conrad, but it is uniformly smaller, less shouldered, flatter of base. The affinities seem to be closer to *A. griffithiana* Lea, which it resembles in form, in both the normal and the produced opercula, and in the tendency to develop the folds characteristic of the *griffithiana* most common to collections. There are specimens which are hard to distinguish from *A. coosaensis* Lea and some of the young are very like the juveniles of *A. ligata* Anth. *Aldrichi* is a good illustration both of the variability of these Coosa races and the marked habit of any given form of Pleuroceridae in any one locality to resemble all other forms there.

The microscopic sculpture varies in strength and it sometimes occurs that the longitudinal lines are less prominent than the revolving lines. Specimens with folds are not uncommon, but the variation from flat and scarcely perceptible elevations to rib-like folds, and their irregularity in many instances probably argues that the character is not fixed or directly inheritable. Material with plicae is comparatively rare, and where it occurs the plications consist merely of low, flattened nodules made a little striking to the eye by spots of dark coloring matter between them.

The color of *aldrichi* varies from yellow to dark brown, olive-green specimens being not uncommon. The larger number of individuals is banded, and often these bands coalesce so that the epidermis has a "zebra" effect. The prevailing banding arrangement is four continuous or broken lines of color, variations consisting of modifications of this formula. In one lot, 111 shells had four bands, mostly discontinuous and frequently with the two inner bands joined or nearly so; 13 had one or more bands suppressed; 74 had bands in the epidermis that did not appear in the aperture; 8 were without any bands.

The embryo shell is very small, smooth, tightly coiled, only slightly elevated. The uneroded adult would probably have five whorls.

The operculum of the type resembles most of the opercula examined,

there being variations in the curve of the margins and the position of the polar point, the form of the apex and the extent of the wear and tear experienced. Perhaps a dozen *aldrichi* were found to have the produced operculum, noted in *griffithiana*. The normal operculum of the latter species is larger than that of the species under discussion, as is also the operculum of *tacniata*. There is, however, a clear resemblance in the opercula of the three species, and *coosaensis* may be included.

Measurements of paratypes:

Altitude	*Diameter*	*Altitude*	*Diameter*
15½ mm.	10¾ mm	13 mm.	9½ mm.
14¾	11	13	9
14	10	11	7½
13½	10¼	10½	8½
13	10		

Anculosa flexuosa H. H. Smith, new species

Fig. 17, 18

Shell: Subglobose, rather heavy, surface broken with stout folds from suture to base and having a half-dozen low, broad nodules at the shoulder which give a flattened effect to parts of the body whorl. Apex flattened, partly eroded. Growth lines fine, worn away in places upon the tops of the folds. Suture impressed, irregular. Aperture broadly ovate, bluish-white, the channels between the surface folds showing through. Peristome a little curved below the suture, quite thin, slightly crenulate. Columella of the type specimen deep purple, rounded, flattened on the surface from the center nearly to the base. Color of shell, buckthorn brown. Within the aperture appear a few spots of color, all that the type has of color bands or lines.

Operculum: Very thin, reddish, translucent, small for so large an Anculosa. Apex acute. Left margin firm, nearly straight, curving abruptly to the apex. Right margin thin, torn, broadly curved. Basal margin worn and broken. Growth lines fine. The polar point is located at about where the left and basal margins meet. Nearly two whorls may be made out within the operculum with the glass. The area of attachment is narrow, elliptical, the deposit of dark callous on the edges being small.

Measurements: Altitude, 17 mm.; diameter, 13½ mm. Aperture—altitude, 10 mm.; diameter, 7¾ mm.

Type locality: Coosa River, Wetumpka, Elmore County, Alabama. Collected by Herbert H. Smith, October, 1903.

Type in the Museum of Zoology, University of Michigan; paratypes in that museum and the Alabama Museum of Natural History.

This species, so far as known, is confined to the vicinity of Wetumpka unless a somewhat puzzling shell more nearly conic, taken by Mr. Smith at Duncan's Riffle, Chilton County, can be assigned to it. Specimens taken by Schowalter, Call and T. H. Aldrich have been brought together in the Alabama collection, indicating that while *flexuosa* is not exactly a common mollusk it cannot be pronounced rare. Possibly it has been fairly widely distributed as *A. formosa* or *griffithiana* by Dr. Schowalter, as individuals have been found in some of Dr. Schowalter's boxes or trays which bear these labels.

Most of the material, like the type, is heavily folded. But a few spec-

imens appear which are wholly or nearly smooth. The nodules are not constant, and when they are present they vary in strength. Judging from the shells examined, color bands or lines are tending in this species to become obsolete. Of 11 specimens in one lot, 7 were without bands or lines, 3 had fine lines broken or continuous, 1 had an arrangement of four very dark continuous bands. The type specimen lacks the heavy callous at the top of the columella, present in some of the material which evidently is older. The columella is ordinarily strong, broad, rounded, tending to become slightly flattened on the outer surface and on the edges near the center. Of the 11 specimens of the one lot mentioned above, the columella was white in 1, purple in 2 and reddish or salmon in the case of 8. The outer lip is sinuous more often than not.

Two forms of operculum were observed, one which is of the *griffithiana* type and the other suggesting relationship with the *picta* group.

Flexuosa is much more robust than *griffithiana* and the development of fine color lines is foreign to that species. Considering size, color lines, opercula and general shell texture and sculpture one might be inclined to think the form a hybrid of *griffithiana* and *picta*. Yet the absence of evidences of hybridization elsewhere in the genus Anculosa discourages this idea.

Measurements:

Altitude	*Diameter*	*Altitude*	*Diameter*
19½ mm.	14½ mm.	17¼ mm.	13 mm.
19	14	14	11½
18	13½	14	11

All from Wetumpka.

Anculosa choccoloccoensis H. H. Smith, new species

Fig. 14

Shells: Obtusely ovate, not heavy, lines of growth rather coarse; spiral striae over parts of the shell, undulate, obscure, not continuous; rest scars prominent. Apex eroded. Suture impressed, a little irregular. Color buckthorn brown; shining; epidermis showing four interrupted bands, the basal band very faint; bands appearing in aperture as lines of dark dots or oblong markings. Columella reddish, strong, rather heavy in the center, regularly curved, the outer edge flattened and nearly at right angles to the body whorl; at the base projecting slightly over the epidermis. Aperture ovate, peristome very thin.

Operculum: Thin, reddish, 7¼ mm. in altitude, 3¾ mm. in diameter. The left margin is nearly straight; right margin curved, firm; basal margin broadly rounded; apex acute. Lines of growth fine. Nucleus indented, located on left margin close to the base. Whorls three, closely coiled. The area of attachment to the foot is narrow, elliptical.

Measurements: Altitude, 13¾ mm.; diameter, 11¼ mm. Aperture—altitude, 6½ mm.; diameter, 5½ mm.

Type locality: Choccolocco Creek at Jackson Shoals, Talladega County, Alabama. Collected by Herbert H. Smith, September, 1905.

Type in Museum of Zoology, University of Michigan; paratypes in the Alabama Museum of Natural History.

This species was collected by Mr. Smith at three localities, Jackson Shoals, Eureka and two miles above the Coosa River, all the stations being upon Choccolocco Creek and within Talladega County. There is only slight variation in the material, though the shells taken at Eureka are uniformly more slender than the Jackson Shoals specimens. In shell characters the adult mollusk is closer to *A. taeniata* Con. than to any other species, but the two carinae on the whorls of the juveniles might seem to indicate a relationship with *A. ampla* Anth.

Six specimens of the type lot are smooth, shining, with only faint revolving striae; 2 have well-marked revolving striae and are somewhat duller; one has a fold 2 mm. below the suture, crossing low plicae and giving a banded effect. A shell from Eureka has fine, erect lines from suture to base, continuous and undulating.

The banding arrangement consists of four lines, usually interrupted, these showing more often in the epidermis than in the shell material of the aperture. A single shell only has five bands.

The columella is normally rounded, rather large; in one old specimen it is heavy and buttressed at the top as in Anculosae of the *picta* group. The color of the columella varies from white to purple.

The embryo shell is small, tightly coiled, the apex elevated. It consists of about two whorls. The juvenile shell does not enlarge rapidly. It has two well-defined carinae at the periphery, characteristic of the young of *A. praerosa* Say, *ligata* Anth. and creek forms of *ampla* Anth. All the juveniles have a weak columella. The four bands are made up of widely spaced dots. A perfect adult would probably have five whorls.

The operculum of this species is rather large in proportion to the size of the shell as compared with opercula of other members of the *taeniata* group. In paratypes, the left margin was found to be more curved than in the operculum of the type. It seemed to be the tendency of most of the animals to wear away the operculum against the columella at the thickened material close to the nucleus. In only the one specimen could the spiral lines be clearly traced.

Measurements:

Altitude	*Diameter*		*Altitude*	*Diameter*	
16½ mm.	10¼ mm.	Jackson Shoals	13¼ mm.	8½ mm.	Eureka
13½	10	" "	12	8	"
13	9½	" "	10¾	8	"

Anculosa brevispira H H. Smith, new species

Fig. 12

Shell: Subglobose, suggestive of *A. ampla* Anth. Longitudinal growth lines rather fine, regularly spaced, crossed over part of the shell by discontinuous revolving lines. Apex slightly eroded, flattened, the whorls developing with remarkable rapidity, this expansion beginning immediately after the embryo whorls. Suture impressed. Body whorl broadly shouldered, bearing four or five low nodules with spots of dark coloring matter between them. Peristome thin, flaring, nearly straight. Columella moderately heavy, flattened nearly its whole length so as to give the inner edge a ridged

effect; color white, touched with red-brown on the outer edge close to the epidermis. Aperture broadly ovate, reddish, having four interrupted, equidistant bands about 1 mm. in width. Color of shell buckthorn brown.

Operculum: Dark red, somewhat thin, in shape like a minute willow leaf; more narrow in proportion to length than the operculum of *A. taeniata* Conrad. Growth lines are well marked, but not particularly heavy. Left margin nearly straight, right margin curved, firm; basal margin broadly rounded, worn. Apex slightly rounded. The polar point is on the left margin close to the base. No trace of the spiral lines can be discovered under the glass. The area of attachment occupies slightly more than half the posterior surface, being elliptical, edged with dark callous.

Measurements: Altitude, 13½ mm.; diameter, 10½ mm. Aperture—altitude, 7½ mm.; diameter, 5½ mm.

Type locality: Fort William Shoals, Coosa River, Talladega County, Alabama. Collected by Herbert H. Smith, June, 1914.

Type in the Museum of Zoology, University of Michigan; paratypes in that museum and the Alabama Museum of Natural History.

This species varies greatly in form, most specimens having the characteristically expanded aperture, but many being as conic as *griffithiana* Lea or *taeniata* Conrad. The young do not closely resemble the adults, the mature characters developing with about the third whorl. The peristome of the juvenile shell is not flaring; it curves at the suture over the early deposit of columellar callous. The upper part of the whorl is more shouldered than in most of the old shells. The affinities of *brevispira* are somewhat obscure, but the impression given during the study of the species is that it is near to *taeniata*.

Numbers of the specimens are folded or slightly ribbed. Occasional specimens bear nodules at the top of the body whorl which may indicate descent from a plicate state. In one lot, 9 individuals have folds from suture to base which vary in strength; 19 have folds at the shoulder only; 59 are entirely smooth.

The color of the epidermis ranges from snuff brown to sepia and a few specimens have the dark mottled appearance of some *A. showalterii* Lea. The bands are usually four in number, continuous or broken. Three variations of the banding arrangement from the normal formula were observed, and each lot collected by Mr. Smith contains shells without bands.

The columella, flattened and a little angular rather than curved, seems to be one of the most definite characters of this race. The lower outer edge is not raised so distinctly above the "abutting" epidermis as in the case of *ampla*. The color of the columella is usually purple. In some it is white and in many specimens it is splotched with purple or red, the ground color being white or pink.

The embryo shell is minute, one and one-half whorls in size, the apex a little raised. The second whorl when completed is very large as compared with the nuclear section. An adult probably has four whorls.

One doubtful specimen of *brevispira* was taken at Three Island Shoals. The species appears to be exceedingly common on parts of Fort William Shoals. It was not found apparently from there down the river until The Bar and Duncan's Riffle in Chilton County were reached, though doubtless it does exist at favorable stations between these shoals. Lower river speci-

mens, rather rare, vary somewhat from typical forms, but are quite recognizable.

The operculum of *brevispira* is very small in proportion to the aperture. As seen in the shell it lies close to the columella, the apex fitting into the corner between the columella and peristome with a little room to spare. At the base, however, is a wide gap and nearly one-third of the aperture between the right margin of the operculum and the peristome is left unprotected.

Measurements:

Altitude	*Diameter*			
18 mm.	13 mm.	Fort	William	Shoals
17½	13½	"	"	"
16½	12¾	"	"	"
15½	11	"	"	"
15½	10¼	"	"	"
14	10	"	"	"
13½	11	"	"	"
13½	9½	"	"	"

Anculosa ampla Anthony

Fig. 23

Anculosa ampla Anth., *Annals N. Y. Lyc. Nat. Hist.*, VI, p. 158, pl. v, fig. 22, 23, Oct. 1855.

Anculosa elegans Anth., *Proc. Acad. Nat. Sci., Phila.*, Feb. 1860, p. 69.

In point of distribution this species is one of the most interesting and certainly the most puzzling of the Anculosae of the Alabama drainage. It is the characteristic member of the genus in the Cahaba River. In the Coosa it has been found sparingly at Wetumpka, close to the mouth of that river, and there only. But north of Wetumpka the species has been collected in five western and three eastern tributaries of the Coosa.

Not another Anculosa of the drainage has so strange a distribution. If this were due to environmental requirements on the part of the species, one might expect to find a similarity in the habitats of *ampla*. There is anything except similarity. In the Cahaba drainage the species occupies not merely the parts which are river-like in character, but also the upper reaches where the conditions are those of a creek, the Little Cahaba River which is more creek than river, and a mineral spring five miles from Centerville which is on the Cahaba. The difference between the Coosa tributaries and the Coosa proper at Wetumpka is that between small streams with lively but not very heavy current and a large river with a strong and, for many months in the year, a deep current. Other Anculosae of the Alabama system are distributed with known or apparent continuity. For example, *A. downiei* Lea lives in the Coosa drainage from the Conasauga to just beyond the middle Coosa Shoals, *A taeniata* Conrad from the middle Coosa to Clairborne on the Alabama.

The explanation for the unusual distributional record of *ampla* which

seems most reasonable at this time is that the species is a relic of a race dating far back in geological time and in the comparatively recent and quite noticable evolutionary alteration of the Coosa mollusca it has disappeared from that stream except at Wetumpka, holding its own only in the tributaries. The ancient lineage of *ampla* is possibly indicated in the shell itself, some juvenile forms of it having characteristics strikingly resembling *A. praerosa* Say of the Tennessee system.

The usual form of *ampla* is subglobose, the aperture ovately rounded, the body whorl shouldered at the suture and there often bearing folds and plicae. Yet in nearly all lots of Mr. Smith's collection many specimens appear which are conic, the aperture narrowly ovate or even elliptical, the surface wholly free of folds and plicae. The pronounced sculpture is more common to the shells of the Cahaba than to the material from the Coosa creeks. Where folds and plicae both occur the region near the suture is usually broken by nodules or tubercles, resembling in this regard *A. plicata* Conrad of the Black Warrior. In the creek forms these characters vary with localities—being a marked feature, for instance, of the Canoe Creek specimens and entirely absent from the Waxahatchee, Buxahatchee and Warson collections. The growth lines of *ampla* are rather strong, the revolving lines usually obscure or often absent.

The species is yellow, dark brown or olive green. The creek forms are easily distinguished from those of the rivers by being brighter, the epidermis having escaped the erosion from sand and the common accidents of heavy currents. About fifteen different arrangements of bands were observed in this study, but most of them were merely modifications of the prevailing formula of four equidistant, interrupted or continuous bands. The creek forms show no marked difference in this character from those of the rivers, though unbanded specimens appear to be rarer in the creeks than in the other localities. In one lot of 224 specimens from Lily Shoals of the Cahaba, 33 were without bands.

The inner edge of the columella of *ampla* is ridged rather than rounded as in other groups of Anculosae. This is plainer in young and half-grown specimens than in the adult. It is not usually flattened on the outer edge, though one lot of creek shells shows this characteristic in virtually all the specimens. The lower third of the columella is produced or flattened as if smoothed with a palate knife. In color the columella is white, red or purple, this last color being the most common. Occasional lots, as those from the Coosa at Wetumpka, have the columella white. The peristome is sharp-edged, firm, usually straight as if the animal held itself tightly to flat stones.

The embryo shell is small, smooth, elevated, rounded and apparently consists of two whorls. Most of the juveniles collected by Mr. Smith have the usual Anculosa form, but specimens from Wetumpka are very much flattened of apex and have the aperture flaring like Neritina. Juveniles taken in Waxahatchee Creek and in the Cahaba River at Centerville bear two carinae at the periphery as in the young of *A. praerosa* Say.

The operculum of *ampla* is dark red to brown, somewhat broader in proportion to length than in the case of *A. taeniata* Conrad. The apex is

rounded, though occasional opercula of the creek forms have the apex acute. The left margin is usually curved, but sometimes straight or nearly so; the right margin is always broadly curved, usually thin and torn; the basal margin rounded when entire. The polar point is on the left margin close to the base, the spiral lines closely coiled, the edges of the whorls within the operculum virtually disappearing after the first one and three-quarters whorls.

Measurements of the shells:

Altitude	*Diameter*	
20 mm.	13½ mm.	Cahaba River, Lily Shoals, Bibb County
17½	13½	" " " " " "
16	11½	" " " " " "
15½	12	" " " " " "
15½	10	" " " " " "
15½	11	" " Pratt's Ferry, " "
14½	10½	" " " " " "
11½	9½	Little Cahaba River
16	11½	Coosa River, Wetumpka
15½	12	" " "
15½	10½	" " "
13½	9½	Canoe Creek, St. Clair County
15	10½	Ohatchee Creek, Calhoun County
14¾	10	" " " "
14	9¾	" " " "
15	10	Kelly's Creek, St. Clair County
13	9	Yellowleaf Creek, Shelby County
14½	10½	Waxahatchee Creek, Shelby-Chilton Counties
13	10	" " " " "

Anculosa mimica H. H. Smith, new species

Fig. 24

Shell: Rather heavy, rough, in form like the subglobose forms of *A. ampla* Anth. Growth lines coarse, revolving lines apparently absent. There are four heavy folds and one light fold at the shoulder upon which are narrow nodules or tubercles suggestive of the sculpture of *Paludomus cōrinata* Reeve. The nodules are strongest near the peristome. Color of epidermis citrine, broken by three well-marked bands, these appearing in the aperture as six very dark, continuous bands. Columella strong, ridge-like at the center, flattened on the outer surface from the middle to the base, outer edge projecting slightly over the body whorl. The columella is nearly pure white and has two small blotches of purple on the inner edge. Peristome flaring as in *ampla*, thin but firm; thickened about 1 mm. within the aperture. Aperture broadly ovate.

Operculum: Similar to that of *A. ampla*. Nucleus pitted, located upon the left margin near the base. Whorls three. The operculum illustrated is slightly deformed at the left margin close to the nucleus.

Measurements: Altitude, 12½ mm.; diameter, 9½ mm. Aperture—altitude, 6½ mm.; diameter, 5½ mm.

Type locality: Little Cahaba Creek, three miles east of Piper, Bibb County, Alabama. Herbert H. Smith, collector, June, 1916.

Type in the Museum of Zoology, University of Michigan; paratypes in that museum and the Alabama Museum of Natural History.

This is a small local race, superficially resembling *A. plicata* Conrad, but more closely related to *A. ampla*. In the type lot, 21 of the shells have the folds as in the type, 10 have strong, oblique plicae crossing three to five folds and ending just below the shoulder, 3 are without folds or plicae. Two or three specimens have small folds continuing from suture to base. There is very slight difference in the form of the shells, virtually all having a flattened apex very little eroded, the flaring peristome and the flat columella.

More shells than any others had the arrangement of six bands of the type. Several modifications, however, were noted; eight specimens of the type lot, for example, having the formula of four bands which prevails in *ampla*. One shell in four of the type lot was melanic.

Little variation occurs in the columella. The color is usually purple. The peristome is straight, a little sulcate in young specimens where the folds reach the outer lip. No shell with perfect apex appears in this collection, but from specimens only slightly eroded the embryo seems to have been about one and one-half whorls in size, smooth and in nearly the same plane. The characteristic sculpture apparently develops immediately with the first growth after the nuclear whorls.

Measurements:

Altitude	*Diameter*			
14½ mm.	11 mm.	Little	Cahaba	Creek
13½	10	"	"	"
13	10	"	"	"
9	8¼	"	"	"

Anculosa plicata (CONRAD)

Fig. 25

Anculotus plicatus Conrad, *New Fresh Water Shells of U. S.*, p. 61, 1834.
Anculosa bella Lea, *Proc. Amer. Phil. Soc.*, II, p. 83, July, 1841.
Anculosa tuberculata Lea, *Proc. Amer. Phil. Soc.*, p. 83, July, 1841.
Anculosa rubiginosa Lea (?), *Proc. Amer. Phil. Soc.*, p. 83, July, 1841.
Anculosa tintinnabulum Lea (in part), *Proc. Amer. Phil. Soc.*, IV, p. 167, 1845.
Anculotus smaragdinus Reeve, *Monog. Anculotus*, t. 3, f. 23, April, 1860.

Conrad described his species as inhabiting "tributaries of the Tennessee River in Alabama." The description of *plicatus* fits the characteristic Anculosa of the Black Warrior River and not at all any mollusk of the Tennessee drainage. That Conrad collected in the Black Warrior is evidenced by his frequent references to the river in his "New Fresh Water Shells," and indeed several of his types came from that stream. If his mistake was not that of confusing notes or labels, he might very well have been under the impression at the time of collecting *plicatus* that his stream belonged to the Tennessee system, for tributaries of the Tennessee and the Black Warrior very nearly interlock.

The question of Lea's *rubiginosa* is discussed elsewhere in this paper. The recognized *tintinnabulum* Lea occurs in East Tennessee, the author

remarking superficial resemblances to *plicata* which later he would probably have considered unimportant.

The peculiar plicae for which Conrad named his species does not occur in all shells. Nor do all the shells have tubercles or beads or sculpture of that nature. The folds upon which the nodules are formed vary in number from one at the suture to several which continue to the base. On one lot from the Forks of the Black Warrior, 19 had each one fold, 5 had two or more, 18 were smooth. Of 94 from Tuscaloosa, 8 only were smooth. Material from shoals near Lock 15 consisted of 66 shells with from one to four folds, 5 with folds to the base, 19 that were smooth. The tubercules and plicae of the Tombigbee River shells were rather obscure. Fine growth lines parallel with the peristome are common to all the shells, varying slightly in strength. Faint revolving lines crossing the growth lines are to be found with a strong glass.

Eight banding arrangements were noted in *plicata* from the Forks of the Black Warrior, the number of banded individuals being only slightly in excess of those without such ornamentation. The most common arrangement was four thin equidistant lines of coloring matter, the two next most common having respectively a line at top and base and a line at suture, periphery and base. In the Jefferson County shells, the arrangement of three bands was the prevailing form and this was so also in the instances of *plicata* from Tuscaloosa and Lock 15. Frequently bands appear on the epidermis while absent in the shell material of the aperture.

The columella of *plicata* is smooth, rounded and usually the upper half is splashed with brown. It has never the gross, buttressed effect which occurs in some of the larger Anculosae of the Coosa River. The aperture is bluish-white as a rule, though sometimes pink or pure white. The peristome is sharp-edged, firm, very slightly curved. Conrad described his shell as "greenish or blackish." Uncleaned shells are covered with a black deposit of mineral matter. Green shells do occur, but brown is the most frequent color.

Even among the juvenile shells individuals with uneroded spires are extremely rare. The nuclear whorls of a specimen from near Lock 15 are smooth, elevated, without sculpture. No line between these whorls and those which follow is indicated. An uneroded adult specimen of *plicata* would probably have seven or eight whorls. Of 32 juvenile shells from the Forks of the Black Warrior, seven are as strongly carinate as the young of *praerosa* Say and serve to make plainer the relationship of *plicata* with *ampla*. The other juveniles are rounded or subangulated at the periphery.

The operculum is dark red, of moderate thickness, sometimes wider just below the rounded apex than at the base. Left margin curved, right margin slightly more so, inclined to tear. Growth lines light to coarse, occasionally fanlike as in opercula among Goniobasis. A few opercula have a wavy sculpture near the outer edge parallel with the right margin. The whorls are three, the first two being more sharply defined than in *ampla*. They are closely coiled.

Measurements of shells:

Altitude	*Diameter*	
18½ mm.	11 mm.	No label
15½	10½	Black Warrior River, Schowalter collection
17	11	Forks Black Warrior, Walker County
15½	12½	" " " " "
14	10	" " " " "
14	10	Black Warrior River, Jefferson County
13	9½	" " " " "
19	13	" " " Tuscaloosa
16½	11	" " " "
15½	9	" " " "
15	10	" " " near Lock 15
13	9	" " " " " 15
12	9	" " " " " 15
15	10	Little Warrior River
16	11	Tombigbee River
15	10	" "

Anculosa smithi Goodrich, new species

Fig. 26

Shell: Subglobose, smooth, shining, the diameter nearly equal to the altitude. Color of epidermis citrine at top and green-yellow at base. A narrow, dark band below the suture, a heavier band at the periphery, which divides into two bands, these becoming obsolete behind the peristome. The sutural band is the only one showing within the aperture. Apex eroded, only the body whorl and part of the next to the last whorl remaining. Lines of growth fine, somewhat irregular as compared with the same character in other species, these being crossed by much finer, discontinuous revolving lines—a somewhat silky appearance being given to the shell under the glass. Suture impressed, regular, a little waving just behind the outer lip. Below the suture is a rather faint line which forms a somewhat angulated shoulder upon the body whorl. Peristome sharp-edged, nearly straight, the shell thickening about 1 mm. just within the lip. Columella rounded, flattened slightly at the base, bluish-white, splashed with brown over the upper half. Aperture ovate, bluish-white.

Operculum: Thin, reddish, translucent, rather small. Growth rays fine. The left margin is curved, thickened; the right margin more curved, thin, broken. The nucleus is close to the basal margin. The spiral lines show three whorls. The operculum of *smithi* is much more like *plicata* than *ampla,* being distinguishable by its smaller size, thinness and finer sculpture.

Measurements: Altitude, 12 mm.; diameter, 8½ mm. Aperture—altitude, 6½ mm.; diameter, 3 mm.

Type locality: Valley Creek, Toadvine, Jefferson County, Alabama. Drainage of the Black Warrior. Collected by Herbert H. Smith, June 27, 1913.

The type is in the Museum of Zoology, University of Michigan; paratypes in that museum and the Alabama Museum of Natural History.

Of 93 shells closely examined, 14 had a single well-marked raised line, more or less irregular, immediately below the suture; in 24 this line was broken, discontinuous or only faintly indicated. The line did not appear on the other shells at all. This would seem to be a character connecting *smithi* with *plicata* of the main stream. About one shell in three is without

bands. Seven different arrangements of the bands were observed, the commonest consisting of a single thin band at the top of the aperture, with two bands at the base. Many of the specimens had bands in the epidermis without showing any in the aperture. In one specimen only were the bands coalesced so as to involve the whole shell. In this case the aperture was purple-colored throughout. The columellae of nearly all the shells were tinged with brown or red from top to center and the columella of one individual was tinged with purple nearly to the base.

No shell with uneroded spire was found in this lot from Valley Creek. Such parts of apices as remain indicate the nuclear whorls are smooth and loosely coiled, the whorls immediately following being without carinae. The largest number of whorls counted was four.

There is a strong resemblance between this shell and the creek and small river forms of *A. praerosa* Say of the Tennessee drainage. Also it is close to *A. plicata* Conrad. A smooth specimen of *plicata* from the Forks of the Black Warrior River, when compared with *smithi,* was flatter of whorls, angulated at the periphery rather than rounded, the columella proportionally not so heavy. A specimen of *praerosa* from Flint Creek, Alabama, a Tennessee River tributary, was slightly more conic, broad of base instead of regularly rounded, the lip having the characteristic curve of *praerosa* instead of the straightness of *smithi.* All three specimens when placed together, while easily distinguishable, yet showed a striking general resemblance. The inclination is to assume that the species under discussion represents a connecting link between the Tennessee Anculosae and those of the Black Warrior. But there is need first of an anatomical understanding of the three species and perhaps of the geological history of the western Alabama stream.

Measurements of paratypes:

Altitude	*Diameter*	*Altitude*	*Diameter*
12 mm.	8 mm.	11 mm.	8 mm.
11½	8½	11	7½
11½	8	10	7½

All are from the type locality.

Anculosa showalterii Lea

Fig. 19

Anculosa showalterii Lea, *Proc. Acad. Nat. Sci., Phila.,* XII, p. 93, March, 1860.
Anculotus sulcosus Anth., Reeve *Monog. Anculotus,* t. 6, f. 44, April, 1861.

This species appears to be confined to the Fort William and Peckerwood shoals of the Coosa River. Judging from the material collected by Dr. Schowalter and Mr. Smith, it is not nearly as numerous in individuals as many other members of the genus.

The *showalterii* which Lea described were "much ribbed . . . with seven transverse ribs . . . outer lip much expanded and very much crenulate." Mr. Smith found and identified smooth forms of the species, corresponding to the smooth forms of the usually heavily sculptured *A. griffithiana* Lea.

The size of the ribs of any individual sulcate shell may differ, and in one lot the number of ribs per individual varied from six to fifteen; in the same lot three juvenile shells had each six ribs. In partly grown specimens the ribs are undercut, i. e., the base of the rib is smaller than the outer surface. As the animal matures base and edge of the rib are on the same plane. Where the ribs fall below six in number there is usually a decrease in their size or strength, and in such instances the sculpture is best described as folds. In material from Fort William Shoals were mollusks with folds at the top of the whorl, becoming obsolete before the periphery is reached; specimens with folds at the suture and upon the base, the space between being smooth; shells with just the suggestion of folds which were confined to the top of the whorl. Fine growth lines crossed by straight or waving revolving lines appear on virtually all the specimens. They are shown most strikingly on the smooth forms, giving the epidermis the silky appearance characteristic of *A. ligata* Anth.

Ordinarily the body color of *showalterii* is very dark brown, but shells occur which are straw color, some somewhat mottled and a few in which the ribs have a lighter color than the interspaces. The bands tend to follow the ribs, but the coloring matter is sometimes absent and in other instances it is spread through the shell material irregularly. In one lot from the Schowalter collection, there are seven specimens without bands to eight having bands. The usual arrangement is four, rather heavy, equidistant bands.

The columella of old shells is heavy, rounded. Shells with a white columella occur, but in most shells it is stained with brown or purple. The crenulate outer lip of which Lea speaks is found ordinarily only in the younger shells, the furrows within the aperture seldom exceeding three mm. in length. As the animal grows older it fills these channels. The peristome has a slight curve at the suture in numbers of the specimens, but usually it is straight and in certain examples almost appressed, as if the habitat were very swift water and the animal clung tightly to the face of the rocks. The color of the aperture is white, reddish, dark red and sometimes almost black.

The embryo consists of about one and one-quarter whorls, quite loosely coiled, in the same plane and widening suddenly at the aperture. As near as can be made out from this material, a perfect, uneroded, adult would not exceed four whorls.

The operculum is of moderate thickness, dark brown or red, nearly twice as long as it is wide. Lines of growth are strong, but not coarse. The left margin is thickened, as is also the right margin in the opercula of old shells; in the young it is thin and usually torn. The left margin is nearly straight, the right curved, the apex not very pointed, the basal margin broadly rounded. Normally the polar point is close to the base of the left margin, but in old and worn specimens this position has shifted toward the center of the basal margin. On none of the material examined could the spiral lines be traced.

The shells of adult animals differ greatly in size. Sulcate forms do not gain the size of some that are only partially sulcate or are nearly or wholly smooth.

Measurement of shells:

Altitude	*Diameter*	
13½ mm.	11 mm.	Coosa River, Schowalter collection
10½	8¼	" " " "
16	11	Fort William Shoals, Talladega County
15½	11	" " " " "
14	11	" " " " "
10	8½	" " " " "
17	12	Peckerwood " " "
16½	12	" " " "
15	11	" " " "

Anculosa lirata H. H. Smith, new species

Fig. 22

Shell: Small, subglobose, in form much like a juvenile specimen of *A. griffithiana* Lea. Body whorl subangular, slightly indented over the umbilicus. The type has nine folds or ribs from suture to base, each of about the same size. The two uppermost folds are somewhat wavy, though no other indication of plicae exists. The longitudinal lines of growth are delicate, but distinct, being crossed by revolving lines; the sculpture having a silky appearance under the glass; this is particularly noticeable in the spaces between the folds. Color dark brown, somewhat mottled. Aperture ovate, having four continuous, equidistant bands. The columella is small, smooth, rounded, purple at the top, white from just above the center to the base. Apex eroded, only a part of the penultimate whorl remaining in addition to the body whorl. Suture not deeply impressed. Lip slightly crenulate, having only a suggestion of the furrows present in many individuals of *A. showalterii* Lea. The lip is not flaring.

Operculum: Thin, dark or rusty brown, about one-half as wide as it is high. Apex acute. Left margin curved, slightly thickened; right margin curved, thin, a little torn. Basal margin injured, but probably broadly rounded in a perfect state. The polar point is near the left margin. The spiral lines cannot be traced. The operculum differs from the opercula of *A. showalterii* Lea and *A. sulcata* Smith in being more nearly oval, more delicate.

Measurements: Altitude, 11½ mm.; diameter, 7½ mm. Aperture—altitude, 7 mm.; diameter, 3½ mm.

Type locality: Coosa River, Fort William Shoals, Talladega County, Alabama. Collected by Herbert H. Smith, June, 1913.

Type in the Museum of Zoology, University of Michigan; paratypes in the Alabama Museum of Natural History.

The type lot of *lirata* consists of three shells only. The species seems to represent a variation of *showalterii* Lea, smaller, more conic, more delicate of sculpture. It differs also in the operculum. The shell suggests a dwarfed *sulcata* Smith, but has a fewer number of folds and lacks the shouldered effect of the body whorl of that species. Connecting forms with *sulcata* appear in material from Three Island Shoals, above the type locality. From Wetumpka material in the Calkins collection, Mr. Smith has separated a shell very much like the type specimen of *lirata* and among Anculosae

collected by Call at the same place are about a half-dozen more shells of the same form. The locality seems to argue that these Wetumpka shells are depauperate forms of *griffithiana* Lea, and doubtless they are when one considers the appparently restricted habitat of the *showalterii* group. The question illustrates the variability of the Coosa River Pleuroceridae and the tendency of each species to develop forms resembling other species in the same locality.

In sculpture, all of the material is very much alike. The Three Island Shoals specimens differ in having larger folds or ribs than the Fort William Shoals specimens, these being also more widely spaced. One of the shells from Fort William Shoals is lighter in color than the type, one darker. One is without bands in the aperture, the other has bands which are interrupted, following the sides of the folds. The banding arrangement in the Three Island Shoals shells are after this pattern rather than that of the type.

Measurements:

Altitude	*Diameter*	
11 mm.	8 mm.	Fort William Shoals, Talladega County
10	7¼	" " " "
13	9	Three Island " " "
12	8½	" " " " " "
11	8	" " " " " "

Anculosa sulcata H. H. Smith, new species

Fig. 20

Shell: Rather heavy, subglobose, nearly as wide as it is high, slightly angled at the periphery and indented a little in the base, resembling *A. griffithiana* Lea in this regard. The type has fifteen strong, narrow ribs of varying size from suture to base. The first two ribs of the body whorl are at right angles to the whorl preceding, giving a decided shouldered effect to the shell. The large body whorl is covered with fine growth lines and these are crossed at places by revolving lines more or less undulate. Color light brown, shining. Three continuous bands show within the aperture, the uppermost being heavier than the other two. Apex eroded, only two whorls remaining. Suture irregularly impressed, almost channeled where the first rib of the body whorl rises above it. Peristome slightly curved, crenulate. Columella porcelain white, smooth, rounded, not so heavy as in several species of equal size. Aperture ovate, yellowish-white, translucent. The aperture is smooth to within one or two mm. of the peristome, thereafter furrowed.

Operculum: Dark, thin, in size 8½ mm. by 4½ mm. Apex rounded. The left margin is firm, the right margin fragile. Lines of growth fine. Polar point is close to the base of the left margin. Whorls three, the spiral lines loosely coiled. The area of attachment is long and narrow.

Measurements: Altitude, 19¼ mm.; diameter, 14½ mm. Aperture—altitude, 14¼ mm.; diameter, 7½ mm.

Type locality: Coosa River, Ten Island Shoals, St. Clair County, Alabama. Collected by Herbert H. Smith, October, 1914.

Type in the Museum of Zoology, University of Michigan; paratypes in that museum and the Alabama Museum of Natural History.

The species is apparently confined to the stretch of the Coosa River

between the shoals a little below Greensport, St. Clair County, and Peckerwood Shoals, near the southern end of Talladega County. Shells from Ten Islands Shoals, Lock 2, Hall's Island and "near the mouth of Upper Clear Creek" are very much alike. The Three Island Shoals material contains shells connecting *sulcata* with *lirata* and through that species with *showalterii*. This relationship is made plainer by the specimens from Fort William Shoals. The one shell taken at Peckerwood Shoals, while having folds, resembles the smooth forms of *showalterii* very much.

In the typical specimens, the ribs vary in size and distance apart. Individuals occur the ribs of which are so flattened that in rubbing the finger over the surface of the shell one scarcely feels the sculpture. A juvenile *sulcata* taken by Mr. Smith has only eight narrow, thin ribs, widely spaced. Another specimen has three strong folds at the shoulder and no more. However, such variation is rare. *Sulcata* is characteristically strongly ribbed. The microscopic sculpture is apparently present upon all shells. In the case of the partly smooth forms, this sculpture has a "cross-hatching" effect beautiful under the glass.

Ten different banding arrangements were observed, the usual arrangement being four continuous equidistant bands. Of 81 shells in one lot from Ten Island Shoals, 16 were without bands, 2 had bands upon the epidermis but not in the aperture, 61 had well-defined bands in the aperture and of these last 45 had the arrangement of four bands. In the transition lot from Three Island Shoals, the bands were broken, irregular, following the sides of the ribs and the channels between, the tops of the ribs having only the usual coloring matter of the epidermis. In the Fort Williams Shoals shells, the thin bands are continuous and appear in pairs. The folds of the dark Peckerwood Shoals shell have small, irregularly shaped deposits of coloring matter which show in the aperture as broken bands.

The columella of most typical *sulcata* is white to bluish-white, occasionally lead-colored above the center, sometimes purple throughout. In the transition forms the purple columella is common, the white comparitively rare. It would appear as if the juvenile shells of the typical forms had columellae more or less touched with purple, this being overlaid in the adult shell by deposits of pure white enamel. The color of *sulcata* ranges from the yellowish-brown of material from the upper river localities, through the mottled shells of Three Island and Fort William shoals to the mahogany-brown shell of Peckerwood Shoals.

The peristome of all the *sulcata* is very slightly curved, usually crenulate and rarely smooth-edged.

The nuclear whorls of *sulcata* are small for the genus, rather tightly coiled, smooth, elevated. The ribs begin to develop with the second whorl. In the case of a juvenile shell from Fort William Shoals, a carina appears at the top of the second whorl, this quickly taking on the appearance of a typical fold or rib. So far as can be judged from the greatly eroded specimens, the species does not acquire more than five whorls.

In only two opercula could the spiral lines be traced. This feature seems to consist of two and a quarter widely coiled whorls within the operculum.

In one case the lines were raised, rough, thickened. In the other the spirals were deeply incised and were much more plainly marked than the first example.

Measurements of paratypes:

Altitude	*Diameter*	
22½ mm	14½ mm.	Ten Island Shoals, St. Clair County
19½	14½	" " " " " "
19	13	" " " " " "
19½	13½	Hall's Island, Shelby County
17½	13½	" " " "
17	11½	" " " "
19½	13½	Lock 2, St. Clair County
19½	13	" 2, " " "
16½	11½	" 2, " " "
16½	12	Three Island Shoals, Talladega County
15	12	" " " " "
15½	12	Fort William " " "
18	13	Peckerwood " " "
15	11½	Coosa River, Schowalter collection

Anculosa occultata H. H. Smith, new species

Fig. 21

Shell: Subglobose, the most Neritina-like of all the Anculosae. Thin. Growth lines very delicate, regular, close together. A few revolving striae appear on parts of the shell, are very obscure and do not continue around the whorl. Apex eroded, body whorl very large, broadly rounded at the shoulder, almost flattened, lacks folds or plicae. Suture not very deeply marked. Peristome thin, but firm, straight, flaring so that the aperture is practically round. Columella regularly curved, broadly flattened on top, the inner edge almost sharp; bluish-white with spot of purple at the top, its junction with the peristome lacking the deposit of callous which fills this area in several other species of the genus. Color of shell brown, with four very dark continuous bands.

Operculum: Thin, red, elongate, apex and basal margin rounded. Growth rays very fine. A few obscure waving lines appear close to and parallel with the right margin. The polar point is placed on the left margin near the base. The spiral lines cannot be made out in entirety, but appear to be widely coiled, as in the operculum of *A. sulcata.*

Measurements of type: Altitude, 11 mm.; diameter, 8¾ mm. Aperture—altitude, 6½ mm.; diameter, 6¼ mm.

Type locality: Coosa River, Duncan's Riffle, Chilton County, Alabama. Herbert H. Smith, collector.

Type in the Museum of Zoology, University of Michigan; paratypes in this museum and the Alabama Museum of Natural History.

The localities in which this species has been collected are Duncan's Riffle, Higgin's Ferry, The Bar, Butting Ram Shoals and "near the mouth of Yellowleaf Creek," all in the Coosa River and within the reaches touching Chilton and Coosa counties.

Most of the shells, including the young, have the Neritina-like form, a few only being found in this collection which are conic as in the case of the juvenile of *brevispira* Smith, which in a way this species resembles.

The sculpture is confined to the fine growth lines and occasional indications of revolving striae. Color varies from yellow to dark brown. In many of the shells the bands are so dark and broad that the ground color of the epidermis shows only as narrow lines. The bands are continuous or interrupted, the formula of four equidistant bands prevailing. Of 125 specimens in one lot from the Higgin's Ferry locality, 111 had the four bands; 2 had five bands; 7 had modified arrangements of the four-banded formula; 5 were without bands. No variation was observed as between localities.

The flattening of the columella was more pronounced in the material from the type lot than in most of the other shells. This, however, is a fairly constant characteristic and is so marked in some specimens as to give them an excavated appearance, this being occasionally heightened by the erosion of the body whorl over the umbilical region. The color of the columella is usually purple, though white is not uncommon. The peristome sometimes has a slight curve close to the suture.

The embryo *occultata* is very small, the apex raised or flattened, loosely coiled, smooth, consisting of one and one-half whorls. In many of the juveniles the peristome is raised at the top above the plane of the apex and the bulk of the shell matter is so crowded into the upper half that the lower half of the shell is made up mostly of a thin columella and a flaring outer lip. This last character is suggestive of *Neoplanorbis smithi* Walker.

Measurements:

Altitude	*Diameter*	
13 mm.	10 mm.	Higgin's Ferry, Chilton County
12½	9	" " " "
12	9½	" " " "
10½	8	" " " "
11	8¼	The Bar, Chilton County
11½	7½	Butting Ram Shoals, Coosa County

Anculosa compacta (Anthony)

Fig. 27

Melania compacta Anth., *Annals N. Y. Lyceum Nat. Hist.*, Vol. VI, p. 123, pl. iii, fig. 22, April, 1854.

Lithasia nuclea Lea, *Proc. Acad. Nat. Sci., Phila.*, XII, p. 188, 1860.

A note by Mr. Smith among his labels reads: "This is the *M. compacta* Anth., *Lithasia nuclea* Lea, *Lithasia compacta* of Tryon and later authors. Certainly not a Lithasia, and that genus has not been found in the Alabama drainage, though several species are incorrectly referred to it. I think that *compacta* is an Anculosa, allied to *A. vittata* Lea. A variety or closely allied species lives in the Warrior."

The judgment of Mr. Smith appears sound. Lea in his description of *nuclea* notes the similarity to Anculosa. It is strange that Tryon should have recognized *compacta* as a Lithasia while placing the allied *melanoides* Conrad of the Black Warrior among the Anculosae.

Though Lea's *nuclea* is credited to the Coosa River there is good reason for believing that the species is confined to the Cahaba River and its tributaries. Lea received his material from Dr. Schowalter, and all the *compacta* which have been found in the Schowalter collection are assigned to the Cahaba.

The sculpture of *compacta* consists simply of fine growth lines, often worn nearly smooth. No revolving lines can be made out with a glass of ordinary power. Color varies from yellow to dark brown. Green shells, especially among the juveniles are fairly common. Bands, where they appear, are three in number, equidistant, varying slightly in width and depth of coloration. Only one banded specimen was found which differed from this formula, the variation consisting merely of the absence of the basal band. The two shells collected by Mr. Smith in the Cahaba at Henry Ellen were without bands. Of one lot of four specimens from Lily Shoals, one only was without bands. In the second lot from this locality, 85 had bands, 26 were without them.

The columella of *compacta* is small, smooth, rounded, angulated at the center rather than rounded. A callous just below the turn is sometimes sufficiently heavy so as to suggest a "tooth". In color the columella is usually white, often marked with purple or red. The Calkins lot has 4 specimens with white columellae; 3 the columellae of which are entirely purple; 5 with the columella part white, part a faded purple. In the larger Lily Shoals lot, white is the predominant color

The form of the species varies slightly. The periphery is frequently subangulated, far more often rounded. A few have the constriction of the body whorl so characteristic of *A. ligata*. In one lot, several specimens have the narrowed aperture and produced peristome of the species known as *Goniobasis louisvillensis* Lea, which is probably a Lithasia. Shells with the apex entire are wholly absent from this collection, but from specimens only partly eroded six whorls for a fully grown *compacta* are indicated.

A form of the species from Buck Creek, a tributary of the Cahaba in Shelby County, is light yellow, flat of whorls, almost pyramidial and without bands. This creek form is exceedingly puzzling because of its resemblance to *Goniobasis germana* Anth. and close study is required to separate the two. This is another illustration of the meager barrier which separates some of the genera of the Pleuroceridae.

The operculum is small, thin, ovate, red. Growth lines and rest scars are rather heavy. Apex rounded, the right and left margins about equally curved. The right margin is thin, the left margin firm. The polar point is very small and near the base of the left margin. The whorls within the body of the operculum are closely coiled, and in the specimen illustrated the total number of whorls is four—an irregularity comparable with an instance occuring in *picta*. Compared with the operculum of *melanoides*, that of this species is darker, heavier, more ovate, the growth lines heavier, the polar point more distinct. Judged by the opercula, the relationship between *vittata* and *melanoides* is closer than the connection between either of these species and *compacta*.

Measurements of shells:

Altitude	*Diameter*						
16¼ mm.	9¼ mm.	Cahaba River, Aldrich collection					
14	8½	"	"	"	"		
13	8	"	"	"	"		
12	7¾	"	"	"	"		
14½	8¼	"	"	Calkins collection			
14	8	"	"	"	"		
11	7½	"	"	Henry Ellen, Jefferson County			
12½	7¾	"	"	Lily Shoals, Bibb			"
12	8	"	"	"	"	"	"
11¼	8½	"	"	"	"	"	"

Anculosa melanoides (Conrad)

Fig. 28

Anculotus melanoides Conrad, *New Fresh Water Shells of U. S.*, p. 64, 1834.
Anculosa turgida Hald., Supplement to No. 1, *Monog. Limniades*, Oct. 1840.

Conrad's description of *melanoides*, like most of the other early descriptions of the Pleuroceridae, is indefinite and incomplete. The diagnosis might fit many other species of the family. The locality given, "inhabits rivers in North Alabama," also lacks definiteness. The foregoing comments apply as well to Haldeman's *turgida*. In the absence of type specimens and a clear description, reliance is placed upon Tryon's identifications and his illustration in recognizing the smaller of the two Black Warrior Anculosae as the true *melanoides*, and upon Tryon again for putting *turgida* down as a synonym.

The uniformity in the size and proportions of this species would seem to indicate that it is one of the older members of the Pleuroceridae, having passed through the era of variability and plasticity and become suited to a varying environment. That it is perhaps a vanishing race might be assumed from the apparently narrow range and the smallness of its numbers. Its competitor, *plicata*, is seemingly far more common and in numbers of individuals exceeds it as in the Ohio River *A. praerosa* exceeds the small *A. costata* and possibly *A. trilineata*.

The sculpture of *melanoides* is confined to fine growth lines which in most specimens, not in all, are crossed by faint, discontinous revolving lines. There are no nodules, tubercules or striae. Upon the adult specimens, the only ones at hand, there occur no carinae. The rest scars are dark and delicate.

The body color varies from yellow to brown, with occasional specimens of a greenish tinge. Yellow bandless forms are so smooth that they shine as if varnished. The number of banded specimens is to unbanded individuals as three to four. Only two banding arrangements were remarked—(1) band at suture and at base; (2) band at suture, periphery and base. The ratio of form 2 to form 1 is five to one.

The columella forms an angle at its center rather than a curve, being

virtually straight from center to base, and at the base slightly reflected. A minute projection or curve at the center of the columella suggests an incipient "tooth," and it is this character possibly which caused Haldeman to liken *turgida* to the Atlantic drainage *A. dissimilis* Say. In color the columella is white, pinkish or reddish; in one specimen it is purple throughout. The peristome is very slightly curved and is bordered with black.

The whorls are flat, the body whorl being subangular. No uneroded shells appear in the Smith collection, but one or two individuals which retain parts of the upper whorls give indication that the spire of *melanoides* is smooth or, in instances, delicately touched with incomplete revolving lines. The maximum number of whorls is probably six.

The operculum is very thin, translucent and yellow-brown in color. The growth lines are regular, somewhat wavy in places and, by transmitted light, these are seen to be crossed by exceedingly fine curving lines from the basal margin to the left margin below the apex. The margins are ragged, even the thickened left margin being torn in some specimens. The polar point normally rests upon the left margin. The spiral development could not be traced.

Mr. Smith appears to have had doubts as to *melanoides* being a true Anculosa. It is one of the border species such as link different genera of this family together, and it might be a matter of personal choice as to where the naturalist shall place it. The nearest relative is *Melania compacta* Anth., of this group, which Tryon placed under Lithasia and which Mr. Smith, in his notes and labels, pronounces no Lithasia at all. The operculum links up *melanoides* with *vittata* more closely than with *compacta*. Until clearly defined anatomical distinctions are discovered, the proper grouping of these shells will remain in question and any argument which could be raised over shell characters of border species alone would represent futile expenditure of breath.

Measurements:

Altitude	*Diameter*	
13 mm.	7½ mm.	Warrior River, Alabama
11	7	" " "
10½	6½	" " "
10	7	" " "
10	6	" " "
9½	5½	Tuscaloosa, Alabama
9	5	" "
8	5	" "

Anculosa vittata Lea

Fig. 29

Anculosa vittata Lea, *Proc. Acad. Nat. Sci., Phila.*, xii, p. 188, 1860.

This species was described by Dr. Lea as from the Coosa River at Wetumpka. Mr. Smith does not seem to have found it there. As there are no specimens in the Schowalter collection it is highly probable that the occurance of *vittata* in this locality is extremely rare and that the few shells of Dr. Schowalter's finding passed out of his hands. Thirty or forty miles north, however, where the Coosa borders Chilton County Mr. Smith found the species in quantity, his three localities for *vittata* being The Bar, Higgin's Ferry and Duncan's Riffle. A note with the lot from The Bar reads "swift water."

Considering the variability of most of the Anculosae of the Coosa, the characters of *vittata* are remarkably constant. The sculpture consists of very fine, hair-like lines of growth and occasional revolving lines which are noticeable only near the suture. These latter lines on the upper whorls of a few specimens are strong enough to suggest carinae. The rest scars, in keeping with the sculpture mentioned, are unusually delicate.

The color varies from yellow to rusty brown, the shells being dull rather than shining. The prevailing arrangement of the well-marked bands is a band hugging the suture, a band at the base and two bands, rather close together, at the periphery. Nine other arrangements were noted in this study, but they are all modifications of the prevailing formula.

The columella is very flat, broad, the outer edge raised above the body whorl. This edge is crescent-shaped as viewed from the side. The inner margin is slightly angled at the center rather than curved, and it here has the mere suggestion of a tooth as in *A. melanoides* Conrad, this character being more pronounced in material from The Bar than elsewhere. The columella is white to bluish-gray, in some specimens purple. The peristome is sharp-edged, firm, usually straight or having only a slight curve close to the suture.

It would appear that *vittata* is not as much exposed to erosion as most of the Anculosae, for entire specimens occur in this material much more than in others. The nuclear whorls are tightly to loosely coiled, smooth, elevated. The development of the shell is so regular that it is impossible to discover the dividing line between the embryo whorls and those which follow. So far as Mr. Smith's collection shows, the adult has not to exceed four and one-quarter whorls.

The operculum is very small, oval, thin, transparent, yellow to brown. The left margin is firm and curved only slightly less than the thin and torn right margin. The basal margin is worn and irregular as if from rubbing against the columella. The polar point is scarcely more than an indentation at the base of the left margin. The spiral development does not show up even under a fairly strong glass. Growth lines are light. In most opercula of this genus, the area of attachment occupies as a rule not more than one-half of the operculum. In the case of *vittata* it appears to involve

virtually the whole of the operculum. This suggests that in this species the operculum is becoming decadent—an assumption supported perhaps by its smallness and thinness.

Shell measurements:

Altitude	*Diameter*	
7½ mm.	6 mm.	The Bar, Chilton County
7¼	5½	" " " "
6½	5	" " " "
8	6	Higgin's Ferry, Chilton County
7¾	6½	" " " "
7	5	" " " "
6½	4½	" " " "
7	5	Duncan's Riffle, " "
6	4½	" " " "

Anculosa ligata Anthony

Fig. 30

Anculosa ligata Anth., *Proc. Acad. Nat. Sci., Phila.*, Feb. 1860, p. 67.

This species is apparently confined to the last seventy-five or one hundred miles of the Coosa River. Shells from the following localities are in the collection brought together by Mr. Smith:

Weduska Shoals and near the mouth of Waxahatchee Creek, Shelby County; near the mouth of Yellowleaf Creek, Cedar Island, Higgin's Ferry and The Bar, Chilton County; Butting Ram Shoals, Coosa County; Wetumpka, Elmore County. In the Schowalter collection, Mr. Smith found *ligata* in material from Buck Creek, Shelby County, which is in the Cahaba drainage. Mr. Smith's label indicates that he doubts the occurrence of the species in this stream. The specimens had probably been misplaced.

Judging from the numbers of shells taken at the different stations, the species flourishes most prosperously on the Weduska Shoals and in the shallows of The Bar. Only two specimens were taken at Wetumpka.

The constriction of the body whorl which suggested to Anthony the name *ligata* is present on all the shells examined. It is sometimes not pronounced, as in the case of the shells from near the mouth of Waxahatchee Creek; sometimes almost channeled, as in shells from Weduska Shoals. No folds or ribs are present and the only features in the nature of plicae or tubercules are irregular nodes near the suture, present only rarely. Striae parallel with the peristome are crossed by fine lines, usually continuous, which are often wavy. Under the glass, the epidermis has the appearance of woven linen. The revolving lines are best shown by half-grown individuals and are stronger near the suture than upon the base of the shell.

Seven different banding arrangements were observed, the usual one being a heavy band at the suture, at periphery and upon the base. The ratio of banded specimens to unbanded is about five to one. Though ordinarily the bands upon the epidermis are broken into squares, within the aperture these bands are usually continuous. In only two specimens does the coloring matter of the bands coalesce so as to darken the aperture.

The columella is light for Anculosa. It is slightly angulated at the center as in *A. compacta* Anth. It is sometimes porcelain white or bluish white, more often stained pink or red. It was noticed in material from Butting Ram Shoals that the shells with a white columella were old. The lip is curved as in *A. praerosa* Say. This curved lip in the case of some specimens gives the suggestion of the fissure of Gyrotoma. The peristome is thin, firm, and in the instance of some old shells it is slightly thickened with callous. The aperture is white, blue-white, reddish, and in some shells yellowish. The color of *ligata* from near the mouth of Waxahatchee Creek is chestnut brown; the Weduska Shoals shells, olive to dark brown; those from The Bar, light to rusty brown. Anthony's shells were dark green. This is a rare color among Mr. Smith's specimens.

The nuclear whorls of *ligata* are raised, smooth, apparently consisting of one and one-half whorls—the line between the embryo shell and the following whorl being hard to make out. The suture is almost channelled on the first two whorls of *ligata*. The typical "cross-hatch" sculpture begins to show upon the third whorl. The periphery of most of the juvenile shells is flattened. The extreme number of whorls of this species is probably five or six.

The operculum is almost oval, dark brown, rather thick, leathery. Edges of both left and right margins are thickened. Lines of growth are coarse, those on the basal margin extending into four to seven stout, thorn-like serrations, curving to the left. The polar point is deeply sunken and is located on the left margin close to the base. The spiral development is obscure, but in one specimen examined the two whorls within the operculum could be traced.

The salient features of *ligata* are the constricted body whorl, the textile-like microscopic sculpture and the hooked processes of the basal margin of the operculum.

Measurements:

Altitude	*Diameter*	
13½ mm.	8½ mm.	Coosa River, Schowalter collection
12½	8½	" " " "
12	8½	" " " "
14½	10½	Weduska Shoals, Shelby County
14	9	" " " "
13½	9½	" " " "
16½	10	Butting Ram Shoals, Coosa County
15	10	" " " " "
16	11	The Bar, Chilton County
15	10½	" " " "
13	9	" " " "
13	9½	Wetumpka, Elmore County
11	8½	" " "

SPURIOUS SPECIES

Anculosa pumilus Conrad, *New Fresh Water Shells of U. S.*, p. 62, 1834.

This is a Somatogyrus.

Anculosa flammata Lea, *Proc. Amer. Phil. Soc.*, II, p. 243, December, 1843.

Description was from a single specimen and was based principally upon a pathological condition in which the coloring matter of bands or lines is deposited longitudinally. Frequently a shell of this kind has bands or lines as well. Several species in the Alabama collection have occasional *flammata* specimens. They are most common in the *picta* group and it is to this group that Lea's species appears to belong, though just to which one it cannot here be said.

Anculosa incisa Lea, *Proc. Amer. Phil. Soc.*, II, p. 243, 1843.

This is *Gyrotoma incisa* Lea.

Anculosa solida Lea, *Proc. Amer. Phil. Soc.*, II, p. 243, 1843.

According to Tryon this equals *Lithasia brevis* Lea, described at the same time.

Anculosa squalida Lea, *Proc. Amer. Phil. Soc.*, IV, p. 167, 1845.

Nothing among Mr. Smith's collections corresponds to the Lea description and Tryon's figure with exactness, and Mr. Smith himself does not appear to recognize it. The type locality is Tuscaloosa, which is on the Black Warrior. The only Anculosa of the size of *squalida* which is known from that stream is *plicata*, described by Conrad in 1834. Lea's figure and Tryon's are of quite different shells and, seemingly, different genera.

Anculosa contorta Lea, *Proc. Acad. Nat. Sci., Phila.*, XII, p. 187, 1860.

No material which can be ascribed to this species appears in the Alabama collection. It was described from one specimen, taken by Dr. Schowalter. It is in all likihood a deformed individual.

Anculosa planulata Lea, *Wheatley Cat. Shells*, p. 28, Alabama; description not published.

Tryon seems to think this equals *A. ampla* Anth.

A mollusk named by Anthony *Melatoma sphaericum* (Reeve Monog., sp. 8, 1861) and recognized by Tryon as a Schizostoma (Gyrotoma) is evidently an Anculosa, probably belonging to a described species of the *picta* group.

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PLATE I

ANCULOSA

Figure 1. *A. aldrichi* H. H. Smith. Type. Coosa River, near mouth of Yellowleaf Creek, Chilton County. (Cat. No. 10139.)

Figure 2. *A. aldrichi* H. H. Smith. Paratype. (Cat. No. 10138.)

Figure 3. *A. ampla* Anth. Lily Shoals, Cahaba River. (Cat. No. 10140.)

Figure 4. *A. ampla* Anth. Coosa River, Wetumpka. (Cat. No. 10142.)

Figure 5. *A. ampla* Anth. Lily Shoals, Cahaba River, Ala. (Cat. No. 10140.)

Figure 6. *A. brevispira* H. H. Smith. Type. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 10144.)

Figure 7. *A. choccoloccoensis* H. H. Smith. Type. Choccolocco Creek, Talladega County. (Cat. No. 10145.)

Figures 8 and 9. *A. clipeata* H. H. Smith. Type. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 10146.)

Figure 10. *A. clipeata* H. H. Smith. Paratype. (Cat. No. 10147.)

Figures 11 and 12. *A. compacta* Anth. Lily Shoals, Cahaba River. (Cat. No. 10149.)

Figures 13 and 14. *A. coosaensis* Lea. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 10150.)

Figure 15. *A. downiei* Lea. Coosa River, near Cedar Bluff, Cherokee County. (Cat. No. 10152.)

Figure 16. *A. downiei* Lea. Coosa River, near Cedar Bluff, Cherokee County. (Cat. No. 10152.)

Figure 17. *A. flexuosa* H. H. Smith. Type. Coosa River, Wetumpka. (Cat. No. 10154.)

Figure 18. *A. foremani* Lea. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 10157.)

Figure 19. *A. foremani* Lea. Coosa River, The Bar, Chilton County. (Cat. No. 10158.)

Figure 20. *A. formosa* Lea. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 10159.)

Figure 21. *A. griffithiana* Lea. Coosa River, Wetumpka. (Cat. No. 10165.)

Figure 22. *A. griffithiana* Lea. Coosa River, The Bar, Chilton County. (Cat. No. 10166.)

Figures 23 and 24. *A. ligata* Anth. Coosa River, The Bar, Chilton County. (Cat. No. 10167.)

Figure 25. *A. lirata* H. H. Smith. Type. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 10168.)

Figure 26. *A. melanoides* Conrad. Black Warrior River. (Cat. No. 10169.)

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PLATE II

Anculosa

Figures 27 and 28. *A. mimica* H. H. Smith. Type. Little Cahaba River, Bibb County. (Cat. No. 10170.)

Figures 29 and 30. *A. modesta* H. H. Smith. Type. Coosa River, Riddle's Bend, Cherokee County. (Cat. No. 10172.)

Figures 31, 32, and 33. *A. occultata* H. H. Smith. Type. Coosa River, Duncan's Riffle, Chilton County. (Cat. No. 10173.)

Figure 34. *A. picta* Conrad. Alabama River, Selma. (Cat. No. 10175.)

Figure 35. *A. picta* Conrad. Coosa River, Wetumpka. (Cat. No. 10176.)

Figure 36. *A. plicata* Conrad. Forks of Black Warrior River, Walker County. (Cat. No. 10179.)

Figure 37. *A. plicata* Conrad. Near Lock 15, Black Warrior River. (Cat. No. 10177.)

Figure 38. *A. plicata* Conrad. Black Warrior River, Tuscaloosa. (Cat. No. 10178.)

Figures 39 and 40. *A. showalterii* Lea. Coosa River, Ala. From the Schowalter Collection. (Cat. No. 10180.)

Figures 41 and 42. *A. showalterii* Lea. Coosa River, Peckerwood Shoals, Talladega County. (Cat. No. 10181.)

Figures 43 and 44. *A. smithi* Goodrich. Type. Valley Creek, Toadvine, Jefferson County. (Cat. No. 10183.)

Figure 45. *A. sulcata* H. H. Smith. Type. Coosa River, Ten Island Shoals, St. Clair County. (Cat. No. 10184.)

Figures 46 and 47. *A. taeniata* Conrad. Coosa River, Ten Island Shoals, St. Clair County. (Cat. No. 10188.)

Figure 48. *A. taeniata* Conrad. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 10187.)

Figure 49. *A. taeniata* Conrad. Coosa River, The Bar, Chilton County. (Cat. No. 10186.)

Figure 50. *A. torrefacta* H. H. Smith. Type. Coosa River, Weduska Shoals, Shelby County. (Cat. No. 10189.)

Figure 51. *A. torrefacta* H. H. Smith. Paratype. Coosa River, Weduska Shoals, Shelby County. (Cat. No. 10190.)

Figure 52. *A. vittata* Lea. Coosa River, The Bar, Chilton County. Cat. No. 10191.)

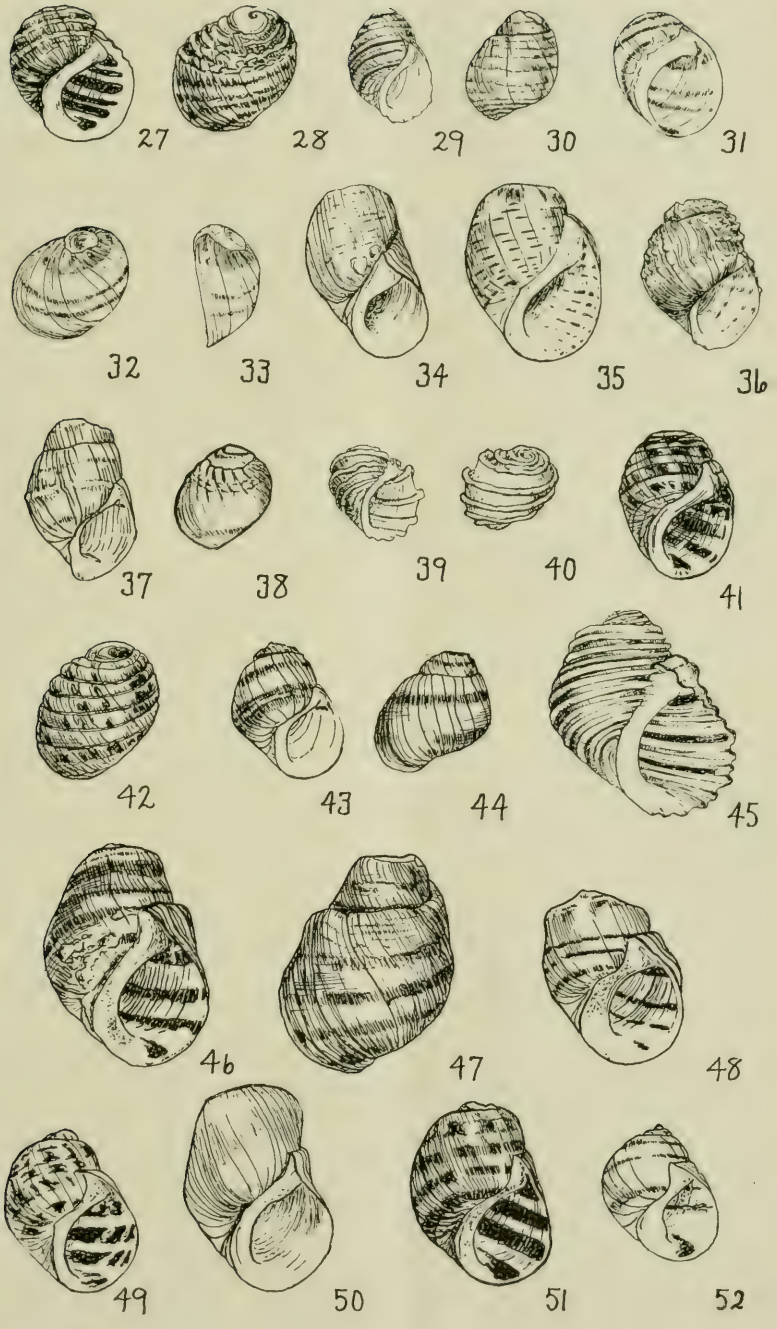
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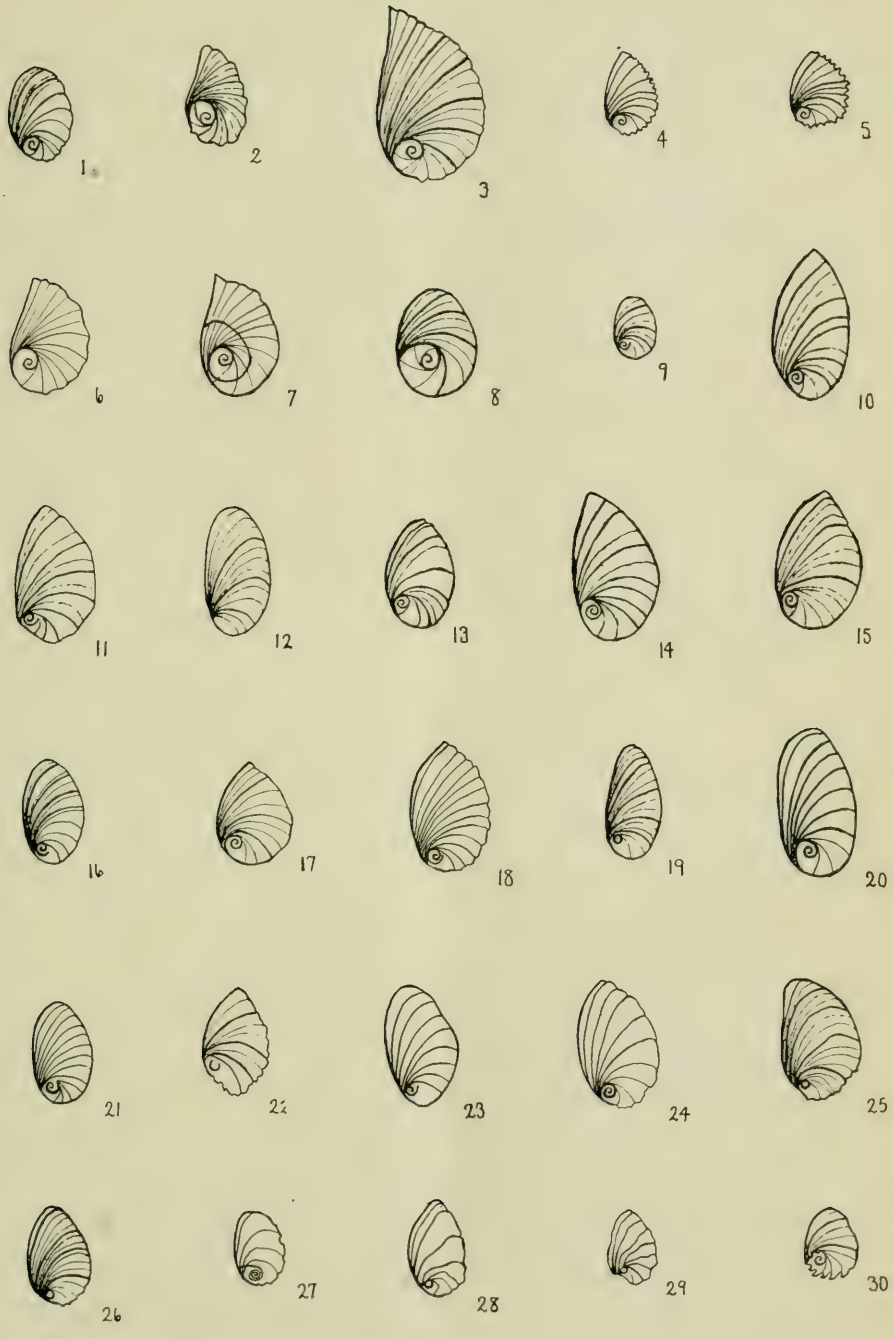
PLATE III

Opercula

Figs. 1, 2 *Anculosa downici* Lea.
Fig. 3 " *formosa* Lea
Figs. 4, 5 " *foremani* Lea.
Figs. 6, 7 " *picta* Conrad.
Fig. 8 " *clipeata* H. H. Smith.
Fig. 9 " *modesta* H. H. Smith.
Fig. 10 " *taeniata* Conrad.
Fig. 11 " *torrefacta* H. H. Smith.
Fig. 12 " *brevispira* H. H. Smith.
Fig. 13 " *coosaensis* Lea.
Fig. 14 " *choccoloccoenis* H. H. Smith.
Fig. 15 " *griffithiana* Lea.
Fig. 16 " *aldrichi* H. H. Smith.
Figs. 17, 18 " *flexuosa* H. H. Smith.
Fig. 19 " *showalterii* Lea.
Fig. 20 " *sulcata* H. H. Smith.
Fig. 21 " *occultata* H. H. Smith.
Fig. 22 " *lirata* H. H. Smith.
Fig. 23 " *ampla* Anthony.
Fig. 24 " *mimica* H. H. Smith.
Fig. 25 " *plicata* Conrad.
Fig. 26 " *smithi* Goodrich.
Fig. 27 " *compacta* Anthony.
Fig. 28 " *melanoides* Conrad.
Fig. 29 " *vittata* Lea.
Fig. 30 " *ligata* Anthony.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THE SIERRA NEVADA de SANTA MARTA—MAIN RANGE

Photographed from near summit of Mt. San Lorenzo

UNIVERSITY OF MICHIGAN

MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 8

The Amphibians and Reptiles of the Sierra Nevada de Santa Marta, Colombia

BY

ALEXANDER G. RUTHVEN

WITH A DESCRIPTION OF THE REGION BY M. A. CARRIKER, JR.

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
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The publications of the Museum of Zoology, University of Michigan, consist of two series—the Occasional Papers and the Miscellaneous Publications. Both series were founded by Dr. Bryant Walker, Mr. Bradshaw H. Swales and Dr. W. W. Newcomb.

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

CONTENTS

Page

Introduction 5

The Field Work 5

Acknowledgments 6

Description of the Santa Marta Region, by M. A. Carriker Jr. 7

The Field Work of the Writer 9

Previous Biological Investigations 15

Geographical Situation 17

Climate 19

Vegetation of the Plains 21

Foothill Vegetation 25

Mountain Forest 25

Paramo Vegetation 27

Mountain Savannas 27

General Character of the Faunas, Mammalian and Avian 28

Conclusion 29

List of Localities referred to by Simons, Brown, Smith, Carriker and the University of Michigan Expeditions 30

The Reptile-Amphibian Fauna and Its Geographical Relations 40

Summary of the Known Fauna 40

Nature of the Material 41

Vertical Distribution 41

Environmental Factors in the Vertical Distribution 44

Relations of the Cloud Forest Fauna 46

Distribution of the Desert and Dry Forest Fauna 48

List of Species 49

Caudata 49

Salientia 49

Sauria 57

Serpentes 64

Crocodilini 69

Testudinata 69

ILLUSTRATIONS

Plate

Frontispiece. The Sierra Nevada de Santa Marta.

I Figure 1. Harbor and city of Santa Marta.
Figure 2. Vegetation of the plains near Santa Marta.

II Figure 1. Wet forest on San Lorenzo.
Figure 2. Moderately wet forest on San Lorenzo.

III Figure 1. Dry forest on San Lorenzo.
Figure 2. Moderately wet forest on San Lorenzo.

IV Moderately wet forest on San Lorenzo.

V Figure 1. A stream on San Lorenzo.
Figure 2. Lower part of the cloud forest on San Lorenzo.

VI A burned area near the summit of San Lorenzo.

VII Vegetation of the region about Riohacha.

VIII Figure 1. Savanna at Valencia de Jesus.
Figure 2. *Drymobius boddaertii* (Sentzen).

IX Figure 1. *Basiliscus barbouri* Ruthven.
Figure 2. *Phrynonax poecilonotus* (Günther).

X Figure 1. *Oxybelis acuminatus* (Wied).
Figure 2. *Drymobius rhombifer* (Günther).

XI Figure 1. *Eleutherodactylus carmelitae,* new species.
Figure 2. *Geobatrachus walkeri* Ruthven.
Figure 3. *Hypopachus pearsei* Ruthven.

XII Figure 1. *Eleutherodactylus carmelitae,* new species.
Figure 2. *Cryptobatrachus fuhrmanni* (Peracca).
Figure 3. *Eleutherodactylus megalops* Ruthven.
Figures 4, 5. *Eleutherodactylus cruentus* (Peters).

Charts

Facing page 40. Altitudinal distribution of amphibians and reptiles on Mt. San Lorenzo.

Page 47. Distribution of common lowland lizards in the Santa Marta region.

Map

Following Plate XII. The Santa Marta Mountains region.

THE AMPHIBIANS AND REPTILES OF THE SIERRA NEVADA DE SANTA MARTA, COLOMBIA

By Alexander G. Ruthven

(With a description of the region by M. A. Carriker, Jr.)

Introduction

The explorations of the University of Michigan in the Santa Marta region have had as the principal object the study of the distribution of several groups of animals abundant in the tropics. It is believed that geography should be emphasized by museums, that the most reliable results at the present time are to be obtained by the study of the distribution of particular groups by persons acquainted with these groups systematically, and that certain problems can best be studied in particular regions.

The groups which have received principal attention in the study of the Santa Marta region are the Formicidae, Amphibia, and Reptilia. Considerable work has been done on the Crustacea, and rather extensive collections have been made in other groups, but the ants, amphibians, and reptiles are the groups studied in sufficient detail to permit of the drawing of general conclusions upon the distribution. This paper contains descriptions of the field work and the region studied and a discussion of the distribution of the amphibians and reptiles.

The Field Work

The specific problems in the distribution of the reptile-amphibian fauna of the Santa Marta Mountains region which were to be investigated were two: to determine more exactly the nature and place of the changes in the fauna which evidently take place in western Venezuela or eastern Colombia, and to obtain more data on the responses of these groups to changes in altitude. It is probably well known to herpetologists that a number of reptiles and amphibians found in northern Venezuela do not occur in western Colombia and that a number of northern Colombian species do not occur in Venezuela, but there has been no evidence of the nature and extent of the changes in the faunas nor data by which the place could be more accurately fixed. Besides being in the general region of the above-mentioned faunal change, the Santa Marta Mountains seemed to offer exceptional opportunities for studies in the altitudinal distribution of reptiles and amphibians. The abrupt rise from sea level to heights perennially covered with snow and the tropical location of the region promised a considerable fauna and sharply delineated distributions.

The first expedition was sent to the region in 1913. The party, consisting of A. S. Pearse, F. M. Gaige, and the writer, spent eight weeks,

from July first, on the west end of the range. During this time collecting was done from the coast at Santa Marta to the bench at 8,300 feet (the Cerro Quemado) on San Lorenzo, the territory covered being a strip through the villages and haciendas of Santa Marta, Bolivar (I)[1], La Tigrera (II), Minca (III), Agua Dulce (IV), and Cincinnati (V), and on the lowlands at La Gaira, Cienega, and Fundacion. Subsequent to this time M. A. Carriker, Jr. made collections which supplemented the series obtained at the west end of the range and provided information on the fauna of the north side of the range from Don Diego to snow-line. In 1920 the writer with Mr. Gaige again visited the range, and during June obtained additional information on the fauna of the forested area on San Lorenzo, exploring the great valleys on the east side of San Lorenzo and the headwaters of the Rio Cordova. In July and August Mr. Carriker, Mr. Gaige, and the writer went to Riohacha by boat, and, securing mules from the Indians, worked entirely around the range by way of Arroya de Arenas, Fonseca, San Juan de Cesar, Valle de Upar, Valencia, and Fundacion, arriving at Santa Marta on August 13. The localities at which collecting was done are given in Mr. Carriker's account which follows.

In the field an attempt was made to obtain data on habits, ecological distribution, and exact limits of ranges, in the belief that the most detailed geographic and ecological data are needed in the interpretation of relationships and distributions. Anyone acquainted with the secretive habits of the amphibians and reptiles, and giving consideration to the size of the region, the diversity of conditions, and the number of species comprising the fauna, will understand the difficulties of the task. No one can appreciate better than the writer the incompleteness of the results. The nature of the field work in itself limited the areas and the forms that could be studied in detail. However, it has seemed that the publication of the results is justified in several ways: The reptile-amphibian fauna was practically unknown; there is a distinct possibility that the natural conditions will be greatly changed in the near future; and certain conclusions, bearing on the general problems which were attacked, are possible from the data.

Acknowledgments: It is with great pleasure, but with considerable difficulty, that the writer attempts to acknowledge the assistance received during the progress of this study. The expeditions were made possible by Dr. Bryant Walker, who has so consistently supported several of the activities of the Museum. In the field the assistance and hospitality of Mr. and Mrs. Orlando L. Flye, Mr. and Mrs. M. A. Carriker, Jr., Mr. Robert Sargent, and Mr. William Flye contributed so largely to the success of the work that it is not exaggerating to say that to them belongs in considerable part the credit for the results obtained. The indebtedness of the members of the University of Michigan expeditions to these persons cannot be satisfactorily expressed, but it should be pointed out that such knowledge as we have of the fauna of the Sierra Nevada de Santa Marta is in no small part due to the assistance and advice which Mr. Flye has so freely and

[1] These numbers are used on the map to indicate the location of the haciendas.

kindly given to collectors, and to the careful field work of Mr. Carriker. The writer also wishes to express his indebtedness to his companions in the field, M. A. Carriker, F. M. Gaige, and A. S. Pearse. Their loyalty and indefatigable efforts to advance the work on the reptiles and amphibians, although principally interested in other groups, made it possible to obtain a large amount of data that otherwise would not have been secured, and contributed to the pleasure of the field work.

The writer is under obligations to Mr. Samuel Henshaw and Dr. Thomas Barbour for the loan of material in the Museum of Comparative Zoology, and to Dr. Henry W. Fowler and the authorities of the Academy of Natural Sciences of Philadelphia for the opportunity of examining the specimens obtained by Mr. J. A. G. Rehn and Mr. Morgan Hebard in 1921. He has also had considerable assistance from Dr. Thomas Barbour, Dr. George Boulenger, and Miss Joan Procter in the identification of specimens, and from Dr. Leonhard Stejneger in the settling of problems in nomenclature.

The writer congratulates himself on being able to publish a description of the region by Mr. Carriker. Certainly no one is more familiar with the area, and no one who has visited it is better fitted to describe the conditions from the biological standpoint. The writer has been able to spend much time in the field with Mr. Carriker, and fully agrees with the interpretations of the conditions given in his account.

Description of the Santa Marta Region

(With comments on the zoological work which has been done there and a list of localities)

By M. A. Carriker, Jr.

The preparation of this paper was suggested by Dr. Ruthven at the time of his second expedition to this region in the summer of 1920. He argued that the information the writer possessed as the result of personal observations over an extended period should be published as an aid to future workers as well as to those who have already made extensive biological studies here. It is due to his enthusiasm and encouragement that I was induced to undertake the work, and it was with his help that the outline of the paper here presented was prepared.

The writer first arrived in Santa Marta in 1909, and with the exception of about two years spent in various parts of the interior of Colombia, has been more or less a constant resident in the region, living in the lowlands near Santa Marta and in the mountains within a radius of twenty-five miles of that city when not engaged in making trips to other parts of the Nevada. (See map following Plate XII.)

As one approaches Santa Marta from the sea (Pl. I, fig. 1) the beautiful snowcapped peaks (see frontispiece) forming the apex of the range are visible for many miles and present an almost irresistible attraction to any lover of the wild and unknown spots of the earth, but especially to the

naturalist, who cannot but be fascinated by the prospect of collecting in this great, isolated, almost unknown mountain mass. The region received the attention of some of the earliest naturalist-explorers who visited Colombia, and many species of animals and plants were described from the meagre collections made here, but the fauna and flora are still largely unknown. To the biologist the interesting features of the Sierra Nevada de Santa Marta are that it is a lofty mountain mass, rising abruptly from sea-level and entirely separated from any other mountain range or system, that it has undoubtedly never been connected with the nearest mountain range—the eastern Andes of Columbia,—and the diversity in conditions. The diversity in ecological conditions is probably exceeded in few areas of the same size, as the range rises from the sea and from lowlands which are arid wastes, or covered with semi-arid woodland or dense humid forests; there are scores of miles of mountain slopes covered in places by a dense tropical forest, in others by semi-arid woodland, and in still others by great savannas or bare, rock-strewn slopes; and the upper regions constitute a vast solitude of *paramos,* extending from the timber-line up to the eternal snows.

In animal and plant life the region is very rich, and there are apparently a large number of endemic species. Of all of the groups represented, only the mammals, birds, reptiles, and amphibians have received particular attention, and even in these groups there is still much to be discovered. The greater part of the region at all altitudes is a vast wilderness, unknown and uninhabited, and the number of biological and archaeological problems is legion.

In this paper I will attempt to give, as nearly as possible, the information on the physical and biological conditions I have accumulated during the past nine years. Since the published data are meagre, this information should be useful to those who shall be able to continue the exploration and study of this remarkable region and its exceedingly rich flora and fauna, and to those who have already done some work in the range, but who do not have a comprehensive idea of the region as a whole and the relations which the different parts bear to each other and to the adjoining areas. It should also assist in preventing useless duplication of work and aid future workers to select untouched fields.

It should be pointed out here that biological work in the Santa Marta range should be done at once if it is to be done at all. There is now beginning a colonization of the mountains which may, in a few years, wipe out the great forest areas and make such changes in the natural conditions that it will be most difficult, if not impossible, to arrive at a correct knowledge of the original composition and distribution of the flora and fauna. There are two colonization schemes on foot now in Germany, with the Sierra Nevada de Santa Marta as their objective, while great interest has been aroused in the region throughout Colombia, and a large amount of land has been taken up during the past two years. A new road has been opened, beginning at Fundacion, the present terminus of the Santa Marta Railway, and extending into the mountains a distance of 25 to 30 kilometers and to

an altitude of about 6,000 feet. Other roads are being projected by the Government and by private interests, and with these once opened it is a foregone conclusion that all the forested country within reach of them will soon be reduced to pasture land and cultivated fields. Already the greater portion of the humid forest, occupying the lowlands on the west side, between Cienega and Fundación, has disappeared, and to get at undisturbed conditions representing this habitat it is now necessary to go to the great forests of the Ariguani, about thirty miles south of Fundacion.

The Field Work of the Writer: I began collecting birds in the Santa Marta district in 1911, arriving at the city of Santa Marta late in May. The first work was done at the *hacienda* Cincinnati (formerly known as Valparaiso). This is the largest coffee plantation in the region and lies on the northwest slopes of Mt. San Lorenzo, between 3,000 and 5,000 feet. It is surrounded by forest extending downward to the foothills and upward to the crest of the mountain, which attains an elevation of 8,300 feet at the western end. More or less continuous work was done at Cincinnati and on San Lorenzo during June and July, and in August, lower down, between Mamatoco and Cincinnati, at La Tigrera and Minca, and Agua Dulce. No more collecting was done until March of the following year, when an attempt was made to reach the Sierra Nevada proper by way of the ridge connecting it with San Lorenzo. Three weeks were occupied in this attempt, which was finally given up as impracticable, after an elevation of about 8,000 feet was reached on the main ridge leading to the *paramos*. There was no trail of any sort, nothing but unbroken forest, and trail had to be cut with machetés. After reaching an altitude of about 8,000 feet progress was checked by an impenetrable mass of brush and huge bromelias from four to ten feet in height. Water was very difficult to secure and birds extremely scarce, so that, after a couple of days of heart-breaking work in an attempt to pass this barrier, the trip was abandoned and the party returned to Cincinnati. After this failure to reach the Nevada, work was continued at Cincinnati and around Mamatoco until the end of April, when I returned to the States for a much needed vacation, having been in the field constantly for nearly three years.

My return to Santa Marta was made in September of 1912, accompanied by Mrs. Carriker. Some intermittent collecting was done in the vicinity of Cincinnati during the remainder of 1912 and the early part of 1913.

In April, 1913, accompanied by Mrs. Carriker, who had now acquired some skill in the preparation of specimens, I again began intensive work which continued almost uninterruptedly during the remainder of 1913. The first locality worked was the valley of the Tamocal Creek, between Mamatoco and La Tigrera. Later the vicinity of Mamatoco and Santa Marta was examined, and several trips were made to Gaira and to the beach beyond. In May a trip was made to the *hacienda* Las Vegas, situated at an elevation of from three to five thousand feet above sea level on the northeast slopes of the Horqueta, near one of the sources of the Rio Men-

daguaca. Two weeks were spent here and very thorough work was done. Birds were not abundant, however, and the ground was broken and the forest difficult to penetrate. The venomous snake known as "Fer-de-lance" was entirely too common to be agreeable and several narrow escapes spoiled the pleasure of collecting.

After returning from Las Vegas, camp was established at Minca for two weeks, and the slopes between 1,500 and 2,500 feet were thoroughly worked, but the heavy rains interfered with collecting.

From July 6, to August 3, work was done at Cincinnati, on San Lorenzo and near Mamatoco, during which time many new forms were added to the list and many loose ends of the problems of local distribution were caught up.

On August 6, a trip was made to Fundacion in company with Dr. A. G. Ruthven and Mr. F. M. Gaige, of the University of Michigan, and Dr. A. S. Pearse, of the University of Wisconsin. Two weeks were spent here with splendid results. The region proved to be a most interesting and fertile field for all members of the party, and many forms new to the general region were taken.

After the return from Fundacion some time was spent looking for particular forms in the vicinity of Mamatoco, Bonda, and Gaira, after which a trip was made on September 26, to Cienega Grande. The party embarked from Pueblo Viejo (near Cienega) in a big "Bongo" or dug-out canoe, with a smaller canoe in tow for shooting purposes. The first stop was made at Playa Caiman, near the northwestern corner of the Cienega, where camp was made on a narrow strip of sand beach separating the Cienega from the sea. All water was brought from near Pueblo Viejo, where it had been carried in canoes from the mouth of the Aracataca River. Life here was a constant torture by day and by night because of the hordes of mosquitoes and sand-flies, which not even a solid muslin canopy would keep out. Our only relief was when there was a brisk breeze from the sea, but it was not the season for the sea breeze, and it came but seldom. Needless to say, all possible haste was made to escape from such an undesirable locality, and after five days we broke camp and fled to the open Cienega in our big canoe, hoping to get at least one good night's sleep. We did sleep, but so soundly that it was not until morning that we discovered that we had been raided during the night by vampire bats, and the whole party was covered with blood-stains from the many bites of these bats. It may seem unreasonable to the uninitiated that we could have been thus bitten and not be disturbed in our sleep, but the fact is that there is no pain produced at the time of the bite, nor indeed for some hours afterward. I had ample proof of this while collecting vampires in an old tunnel in Venezuela. I caught the bats in an insect net and then seized them carefully by the nape of the neck and thrust them into cyanide bottles. Their skin is very loose around the neck and several times they succeeded in wriggling about and nipping my fingers. On such occasions I never knew I had been bitten until I saw the blood flowing from the wound.

After a bath and breakfast we put up our sail and headed for Trojas

de Cataca, a fishing village built on piles over the water at the mouth of the Aracataca River. We secured quarters in a comparatively new house and made ourselves fairly comfortable, although the odor of drying fish was very disagreeable for several days until we became somewhat accustomed to it. It was a pretty sight to see the little fleet of fishing canoes sail away at dawn in search of the great schools of Lisa. When luck was good the canoes would return between three and four o'clock, loaded to the gunwales, and then there was pandemonium let loose in the village. Singing, shouting, whistling, and laughing, while everyone big enough to wield a knife joined in the task of cleaning them for drying, this operation usually consuming half of the night. When the catch was very great the entire night was spent in festivities.

Practically all shooting in this vicinity was done from a canoe along the shores of the lagoon or up the streams entering into it, for at this season of the year the shores of the Cienega are inundated for a long distance inland. Herons, terns, and ducks were abundant, while the forests were teeming with parrots and monkeys. Occasionally a Manatee was seen at the mouth of the river, but none were secured. October 3 to 14, was spent here and many aquatic forms were secured. Little or no work was done between the return from Cienega Grande and our departure for the Sierra Nevada in January of the following year.

On January 10, with Mrs. Carriker and one Colombian assistant, I left Santa Marta for the north coast, going by land, with pack mules, as far as Don Diego. The trail was a trail in name only and was almost impassable. Three and a half days were consumed in reaching Don Diego. The trail passes through Mamatoco and Bonda, and thence along the road to Don Amo for a short distance, when it turns off to the left and crosses over into the valley of the Jordan, passing through Calabaso and Cacagualito, thence down the Jordan to the Rio Piedras, then down the Rio Piedras to the sea. From here the open beach is followed to Don Diego, except where detours inland are necessary to cross the rivers Mendaguaca, Guachaca, and Buritaca.

We arrived at Don Diego at dusk, after thirteen hours in the saddle; tired, hungry, and covered with bites of black flies, sand-flies, mosquitoes, and wood ticks, the latter being still attached in myriads to our persons. A hurried rub-down with kerosene removed the ticks, after which a delightful sea bath somewhat restored our flagging spirits, and a good supper provided by our genial host, Mon. Barbier, completed the restoration.

The whole northeast coast and the hills up to 3,000 feet or more contain more insect pests than any place I know of in Colombia, excepting some portions of the Atrato basin, and Don Diego proved no exception to the general condition. The attacks of flies and mosquitoes can be checked to a certain extent by the use of "dopes" or nets, but there seems to be no effective relief from the ticks, which cannot be entirely avoided and are, in many places, a serious drawback to the best field work.

Don Diego is a French plantation which at the time of our visit was

largely abandoned, and is now entirely so. It is in the heart of the heavy, humid forest which reaches to the very beach all along the northeast coast east of the Rio Piedras. A month was spent here, not because we wished to stay, but because we could not get away, since the trip to Dibulla was to be made by sea in a large dug-out canoe, and the canoe was not forthcoming. To secure the canoe it was necessary to make the trip to Dibulla, which I did, accompanied by our assistant, and riding the two mules, while Mrs. Carriker remained in Don Diego. After two days of strenuous endeavor and the promise of an exorbitant sum, a canoe and crew of five men were secured. We embarked in the evening, with a fresh northeast wind astern, and reached our destination early next morning. Then followed a half day of frenzied packing and at 4 P. M. we embarked and attempted to put to sea. There is no harbor of any sort at Don Diego, merely an open beach, and in passing the second line of breakers we were nearly swamped and were forced to return to shore, with much of our outfit wet and damaged by the salt water. The next afternoon we made another attempt which was more successful, and we reached the open sea with only a slight wetting in the outer line of breakers. Thirty-six hours were spent in getting to Dibulla, bucking the wind and strong current. We arrived at dawn, nearly exhausted from the cramped position in the canoe and lack of proper food.

No pack animals were available in Dibulla, and it became necessary to send to Pueblo Viejo for them. In the meantime we spent ten days very profitably in collecting around the *hacienda* La Victoria (near Dibulla), where we had been most hospitably received. No collecting had ever been done here and much interesting material was secured. Our baggage was taken to Pueblo Viejo on oxen, while we rode our own saddle animals. Owing to the slowness of the oxen we were compelled to spend a night on the road, reaching Pueblo Viejo at about 2 P. M. the second day. We pitched camp on the banks of the Rio Ancha, about half a mile from the village, thus escaping the too persistent visitors, including pigs and dogs, of the town. W. W. Brown had done considerable collecting at this place, but nevertheless much new material was secured and many new records made. Pueblo Viejo is only about 2,000 feet above sea level, surrounded by broken country, which has for the most part been cleared and has now reverted to scrub or savanna. Our old friends, the wood ticks, which were so numerous both at Don Diego and Dibulla, were much in evidence there and caused no end of annoyance. After returning from a morning's shooting it was almost always necessary to strip completely, sponge off with kerosene, and then bathe in the river to remove both ticks and kerosene, while the clothing went into a can of boiling water. From this base the valley and heights of Chirua were worked, as well as the valley of the Rio Ancha above for a long distance, and also the Macotama Valley as far up as Santa Cruz.

We secured oxen from the Indians of San Miguel for the transportation of our equipment to that village, a special trip having been made there

for that purpose. We arrived at San Miguel late in the evening, spending the night in the "guest house" of the village, and crossing the river the next morning to the plateau opposite where a camp site had been prepared in advance. The whole of the Macotama Valley, from where the road enters it below Santa Cruz up to the *paramos,* is largely deforested, the mountain slopes being largely unbroken savanna, except in the ravines, the only forest left being along the crest of the ridges and on the upper slopes. As a rule, what woodland was left was invariably on steep north exposure, land unsuitable for cultivation by the Indians.

We spent five weeks in camp at San Miguel, using that as a base for all work from there (5,500 feet) up to the snow line. An unfortunate, though unavoidable misunderstanding with the old chief, brought about by our failure to present him with a large jug of rum, was the cause of our not being able to secure oxen for moving our camp to higher altitudes. He even forbade us to shoot on the *paramos,* but we paid no attention to him, promptly going up the valley the next day to 10,000 feet, without hindrance.

Virgin forest was found at San Miguel only at long distances from camp, which made it necessary to spend many nights in the field in order to get the morning shooting, sleeping sometimes in the forest on the ground and other times in deserted Indian huts. No guides could be secured from the Indians, so that we were reduced to "following our noses" until we found what we wanted. The first time I went up to Lake Macotama I started at 5 A. M. on muleback, riding up to 9,000 feet, where the mule was left and the journey continued on foot. At noon the lake was reached (15,000 feet), where lunch was eaten, after which I returned to camp, reaching it at 7 P. M. with a good bag of birds, but well tired out. Lake Macotama certainly rivals many of the Alpine lakes in beauty and grandeur of scenery. In shape like a half horseshoe, it is about three-quarters of a mile long and from 300 to 400 yards in width, and is almost surrounded by beetling crags and cliffs of nearly naked rock rising to a height of about 1,400 feet above the surface of the lake. Down on one side, less precipitous than the rest, dashes a little stream of water from the melting snows above. The colors of the lake are exceedingly beautiful. Along the grassy shores the water is pale green, gradually becoming darker green, then merging into blue-green, light blue, and finally into the deepest ultramarine, showing that the lake must be of profound depth.

Later, when we all went up to the snow, we left camp very early, taking the two mules, Mrs. Carriker mounted on one and a pack on the other. We again left the animals at 9,000 feet, dividing the pack between the hunter and myself. We reached the lake at 4 P. M., ready to drop from fatigue, for the packs contained food for three days, blankets, guns, ammunition for three days' shooting, camera and aneroid. Camp was made on the lake shore under the lee of a gigantic boulder. We secured a good supply of fire-wood, ate supper, and turned in, to pass a wretchedly cold and miserable night, with the temperature down to 26° F. Next morning, after a hasty breakfast, we started by moonlight at 4 A. M. to climb

the cliff along the course of the little stream, which seemed to be the only feasible mode of ascent to the heights above. The top was reached after an hour of hard climbing, and another lake, a small and shallow one, was discovered there, from which stretched a comparatively gentle slope up to the snows. Respiration now became more and more difficult, and halts more frequent and longer. Our native helper succumbed to mountain sickness and was of little use until the following day, after we had descended below 12,000 feet. At last the snow was reached and its glittering slopes ascended for some distance, to an altitude of approximately 17,500 feet. To our keen disappointment, we now discovered that further advance along this route was impossible, for here began a knife-edge ridge of jagged rock which extended nearly a mile to the slopes of the main snow peak, the passage of which appeared an utter impossibility. To approach the heights above from any other direction meant a descent of at least 2,000 feet into another valley opening out toward the north, in which lay another fairly large lake. From this valley an uninterrupted slope leads up to the highest point of the Nevada. Such a detour meant at least another day, or even two, and we had insufficient food to make the attempt. We turned back and spent the rest of the day shooting in the valley below snow-line, where birds of several species were fairly common, one of which was the strikingly handsome humming-bird *Oxypogon cyanolaema,* which feeds largely on the flowers of the "Frailejon," and which is peculiar to the Sierras of Santa Marta. In the little stream above the upper lake we discovered numerous individuals of a fine new amphibian, later described by Dr. Ruthven as *Atelopus carrikeri.* On the shores of Lake Macotama was taken a single specimen of our beautiful North American warbler, *Geothlypis trichas,* the first record for South America.

After another disagreeable night on the shores of Lake Macotama, we started back to San Miguel, collecting along the way, and reached camp without mishap late that evening. I afterwards made another trip to the lake with my hunter, sleeping the first night a short distance below the lake, where we had a more comfortable camp, and on the second night in an Indian hut at 11,000 feet. On this trip the *paramos* between 11,000 and 15,000 feet were thoroughly worked and much valuable material collected.

Later in April, after a few showers had warned us that the rains were near, we broke camp, sent to Pueblo Viejo for oxen (the chief still being disgruntled), and started for the coast, where we arrived in four days. From Dibulla we proceeded by canoe to Riohacha, reaching there in one night's travel. A week was spent at Riohacha in strenuous collecting. The intense dry heat of the sandy wastes and low scrub around the town were very trying, after having descended so rapidly from the cold temperature of the high altitudes, and we found it impossible to stay out after 9:30 A. M. Fortunately, the thorny scrub surrounding the town was fairly swarming with birds, so that with three hours' shooting enough material was secured between the two of us to keep all hands busy the remainder of the day in preparing it.

A few more days of collecting would have been desirable, but a schooner

was leaving for Santa Marta, and since transportation between these places is very uncertain we could not afford to let the opportunity go by. We embarked in the evening, and at dawn of the second day reached Santa Marta, after a calm and uneventful voyage, just four months from the day we had started. Altogether it was a most successful trip, although many difficulties and delays were experienced which might easily have been avoided had it been possible for us to secure in advance even the most meagre information about the region we intended to visit. While the Indians were extremely shy and distrustful of us, they were honest and inoffensive, never molesting us in any way or coming near our camp during our absence.

After the trip to the high altitudes some time was spent in revisiting certain localities on the west end of the range to supplement collections. Evidently the next work to be done was a reconnaisance of the east and south sides of the range, and in 1920 the opportunity presented itself. In July and August Dr. Ruthven, F. M. Gaige, and I went to Riohacha from Santa Marta in a small schooner.

We worked at Riohacha for ten days, and then, with mules secured from the Indians, made a trip entirely around the Nevada, by way of Fonseca, San Juan de Cesar, Valle de Upar, Fundacion, and Cienega. The trip was most successful as a reconnaisance, and even more than this, as detailed work was done on the reptiles and amphibians, and at the same time sufficient data was secured to clear up numerous questions on the nature of the vegetation of the southern slopes and contiguous lowlands and the distribution and origin of the fauna of that side.

It will be clear from this account that while much has been accomplished both by previous workers and ourselves, there still remains a vast amount of detailed work to be done. To be worth while, collecting must be carefully done, for the diversity of conditions and the differences in altitude within short distances render collections with general data almost valueless.

Previous Biological Investigations: The late Mr. H. H. Smith arrived in Santa Marta in May, 1898, with his wife and two other assistants. They made their first headquarters at Bonda, where they remained for a considerable period, working the surrounding country for long distances. Mr. Smith himself did no collecting of birds or mammals, and probably secured but few reptiles and amphibians, confining his efforts to botanical and entomological work, in which he was, I understand, most proficient. All vertebrates collected were taken by native hunters employed by him, so that as a consequence we have a vast collection of skins labelled "Bonda" which in many instances came from places far removed from that village, both in actual distance and especially in altitude. Bonda lies in the valley of the Rio Manzanares, at about 200 feet above sea level, but near the foothills of the Horqueta Mountain, so that a collector starting out from Bonda might easily reach an altitude of 3,000 feet or more in a day's shooting. For this reason it is impossible to use much of Mr. Smith's data for plotting altitudinal distribution of species. This is especially true of his work

done at Bonda, although it holds good also for many specimens labelled "Valparaiso" and "El Libano." The Valparaiso of Smith is today the *hacienda* Cincinnati, and El Libano is the mountain ridge lying between Cincinnati and the adjoining coffee estate of La Victoria, which descends from the Cerro Quemado of San Lorenzo. There is no doubt that Mr. Smith took every precaution to label his specimens correctly, but when native hunters are employed it is not possible for a person who is unfamiliar with the local topography to tell from a hunter's description just where each specimen was secured. Also, the hunters themselves do not always remember and are very apt to give fictitious localities for specimens when they have forgotten the true one. In those days the importance of altitude in determining the distribution of species was not appreciated and most collectors paid little attention to it, so that they might be working on the slope of a mountain, with headquarters at 4,000 feet, and make collections from 2,000 to 6,000 feet or more, and give all specimens the locality of the base of operations.

Mr. Smith later spent some time at Don Diego, where Mrs. Smith was very ill, and while a great amount of material was collected there much of it was lost, and no detailed report was ever made on the remainder by any institution. Mr. Smith's work in the Santa Marta region was confined to the following roughly outlined sections: The valley of the Rio Manzanares from Mamatoco upwards, covering the lower slopes of the Horqueta and extending northward over the Matagiro Valley and the median part of the valley of the Jordan, at Cacagualito and Calabaso; the northwest slopes of San Lorenzo, between 2,000 and 7,000 feet, between Minca and the upper slopes of the Cerro Quemado; the vicinity of the town of Cienega (sometimes called San Juan de Cordoba) and southward as far as the Rio Orihueca, and lastly at Don Diego.

It is a pity that his specimens could not have been more carefully labelled as to altitude, because a great quantity of skins were made which would now be of inestimable value in plotting the local distribution of species in the regions above enumerated. He deserves, nevertheless, great credit for what he did accomplish, as does Mrs. Smith, because she superintended all the bird and mammal work and did much of the taxidermy herself. They worked in the region at a most difficult time, as it was during the late revolution, which caused them no end of annoyance. Also, the country around Santa Marta was much more of a wilderness then than now, with almost no roads or trails and very few settlements in the mountains.

Mr. W. W. Brown arrived at Santa Marta shortly before Mr. Smith and almost at once made his headquarters at Bonda, staying with Mr. Orlando L. Flye, who was in charge of the electric power plant at Bonda. All the material collected by Mr. Brown in the vicinity of Bonda and Santa Marta was labelled "Santa Marta," and is, as a consequence, worse than useless for plotting distribution, since it is actually misleading in many cases. After working at Bonda he went to the Sierra Nevada, where I have little knowledge of his work except what was given me by two men living in

Pueblo Viejo, who had been employed by him as hunters during all his activities on the north slopes of the Sierras. Contrary to Mr. Brown's statements that he himself collected all of his specimens, I have unquestionable first-hand information that both in Bonda and in the Sierras, at least at Pueblo Viejo, San Miguel, and the *paramos,* he did little or no shooting, employing native hunters for that purpose, while he prepared the specimens. As in the case of Smith's data, I would hesitate to use any distributional records based solely on Brown's collections, unless supported by other data. Mr. Brown worked both sides of the Sierras, at Pueblo Viejo (then San Antonio), Chirua, Santa Cruz, San Miguel, and Macotama on the north slopes, and San Sebastian, Pueblo Viejo, and El Mammon on the south slopes, as well as the intervening *paramos* of Macotama, Chiruqua, and Chinchicua. Notwithstanding the fact that he passed through Dibulla and Riohacha and traversed the road from the latter place to Valle de Upar, no collecting was done in any of these regions, so that the first definite information secured concerning their bird fauna was by the writer at Dibulla and Riohacha in 1914 and along the road from Riohacha to Valle de Upar and thence around to Fundacion in 1920, when attached to the University of Michigan expedition.

It is to be understood that I have no reason for making these comments upon the work of Brown and Smith other than the desire that our knowledge of the fauna of the region should be free from the confusion caused by inexact records.

Geographical Situation: The geographical boundaries used for the region discussed in this paper (*cf.* map) are as follows: On the north and northwest the Carribean Sea; on the northeast and east the Goajira Peninsula, or, more exactly speaking, the Rio Rancheria (called Calancála on its lower reaches), up to where it turns abruptly northwest to enter the Sierras; from this point on the Rio Rancheria on a straight line to San Juan de Cesar, on the Rio Cesar; thence down the Rio Cesar to where it divides into two channels (Caño Corredor and Caño Matanza); from this point in a more or less straight line to Alto de las Minas, passing through Camperucho, and thence to Ariguaní; from there the trail to Fundacion, the terminus of the railway from Santa Marta; and from Fundacion a line to the south end of the Cienega Grande and thence across to Playa Caiman and the sea. The line running across from the Rio Cesar to Cienega Grande is a purely arbitrary one, since it does not designate the boundary of any known habitat. However, the upper Rio Cesar and Rio Rancheria represent an actual faunal and physiographical boundary between the Sierra Nevada and the eastern Andes, and I have used no records from localities on the slopes or foothills of the eastern Andes, such as Villanueva and Manuare (included by Simmons). The lower Rio Rancheria is also an arbitrary boundary line, since it traverses the arid Goajira Peninsula and cuts through a distinct faunal area which is well represented around Riohacha. Thus we have in the mountain mass an absolutely isolated area containing its own distinctive habitats and faunal characteristics, into which

enter but two outside influences, that of the Magdalena basin on the southwest and that of the central plateau of Venezuela through the Goajira Peninsula on the east.

The great mountain mass known as the Sierra Nevada de Santa Marta is, roughly speaking, in the form of a trihedron, with the San Lorenzo and Horqueta peaks and outlying ridges forming the northwest edge; the end of the long spur ridge which disappears in the big bend of the Rio Rancheria, the northeast edge; and the great southwestern buttress between the Rio Ariguaní and Guatipuri, which ends at Alta de las Minas, forming the southwestern edge. The vertex of the trihedron, massive central peaks, covered with perpetual snow and rising to an altitude of not less than 18,000 feet (probably more), lies somewhat nearer to the northwestern edge, The base of the north face of the trihedron is about 90 miles long, that of the southeastern face about 120 miles, and that of the western face about 90 miles.

It will be noted that the Santa Marta Mountains have a remarkably small base for the heights attained. There is an almost complete absence of foothills between the points forming the three angles of the trihedron, the mountains rising rapidly and in many cases very abruptly from the surrounding plain, which is for the most part but a few hundred feet, or less, above sea level. Consequently, there are no broad valleys anywhere on the lower slopes of the mountains, and the numerous rivers rush down from the high altitudes to the plains below, carrying vast quantities of silt which is dumped into the Rio Magdalena, the Cienega Grande, and the Caribbean Sea. It is only in the Cienega Grande that an adequate idea may be obtained of the immense amount of material which has been carried down by these streams. In this great lagoon the detritus has extended the shore line for long distances and filled up what was evidently once a deep arm of the sea, until today it is but a shallow lagoon with mangrove swamps encroaching upon it from all sides. No less than seven large rivers drain the north slopes. On the south side are four magnificent streams, all having their source in the snow, while on the west side are six of nearly equal size. The largest streams are the Rancheria, Badillo, Guatipuri, Ariguaní, and Fundacion. The existing maps of this region are very inaccurate in many respects, particularly in the plotting of the rivers. They convey an erroneous impression of the mountain ridges separating the various drainage basins, the long, bold ridge running east into the great bend of the Rio Rancheria being poorly indicated, as well as the one, even higher and wider, which ends at Alto de las Minas, forming the southwest apex of the triangle.

The mountain valleys are narrow and V-shaped, with little or no flood plain until the plains are reached, where they burst out into the surrounding lowlands and deposit great masses of boulders and gravel in parallel ridges resembling lateral glacial moraines. The slopes of the mountain valleys are, for the greater part, steep, and in many instances precipitous, especially on the south sides of the ridges, which would suggest a tipping up of the strata in some remote geologic time. The ridges are for the most part nar-

row, even knife-edged, the crests often being but a narrow wall of rock, in places but a few feet in width along the crest. As the higher altitudes are approached, and one emerges above the "cloud zone," where the precipitation is less, the ridges become broader and more rounded, with remains of plateaus and gentle slopes. The valleys are broader and shallower, and on the vast *paramos* surrounding the snow peaks are to be found great undulating tracts of open moorland, broad valleys, and gentle slopes, with many small, picturesque lakes.

These mountain lakes were possibly caused by glacial action in the remote past, and many of them have been nearly filled with silt from above in comparatively recent times, but at the present day no true glaciers exist in the Sierras, to my personal knowledge, unless some very small ice masses are included under the term. I doubt whether any very large glaciers ever existed in the Sierra Nevada de Santa Marta, since I have been able to identify no moraines. I suspect the cause of this absence of glaciers to be the complete isolation of the range and the lack of great buttressing foothills and mountains such as abound in the Andes. The rapid and unopposed ascent of the superheated air from the lowlands and its direct action on the snow masses above cause a much higher temperature and higher snowline than would otherwise be the case at these altitudes.

The topography of the Sierra Nevada de Santa Marta might be considered to indicate that the range is young, but this does not necessarily follow. Traces of volcanic action are wanting and the exposed strata show clearly that the range has been thrust up. The exposed rock is largely granite and in the greater part of the region the subsoil is a peculiar decomposed granite, abounding in fine particles of mica. While clay deposits are present in many districts, they are decidedly less common than the decomposed granite. I have seen limestone in only one small district, on the road between Fonseca and San Juan de Cesar, where the road skirts the base of the foothills. This limestone area is but a few miles in length (east and west), although it may extend far out into the valley.

The narrow knife-edged ridges in many places seem to be the result of great vertical masses of hard rock which resist erosion along the tops of the divides and maintain the steep slopes. Ridges composed almost entirely of great masses of boulders and solid rock are very common. In addition to the resistance of the rocks and soil to erosion, it must be remembered that the east, north, and west slopes of these mountains from the lowlands to the timber line are clothed with a dense forest growth, and that on the south slopes, while the forest growth is largely absent and the topography is nearly the same as on the other slopes, the ridges are inclined to be broader and more rounded. The conditions thus seem to favor the persistence of a youthful topography.

Climate: The seasons are more or less the same on the different slopes and the contiguous lowlands, although the humidity and the temperature vary greatly on the different exposures, due principally to the trade winds. The surrounding lowlands possess the usual tropical heat of these latitudes,

tempered on the north coast by the trade winds and sea breezes, but are very hot on the west and south sides during most of the year. Ascending the mountains, the temperature gradually lowers. Between 4,000 and 5,000 feet is an ideal climate, having a minimum temperature of about 60° F. and a maximum of 80°, where an open fireplace is a great comfort at times and woolen clothing almost a necessity, especially during the rainy season from 5,000 feet upwards. When 8,000 feet is reached the minimum drops to an average of about 54°, and it is always chilly in the shade, while in the open the direct sun's rays are blisteringly hot around midday. At 9,000 feet, or a little above, the mercury drops to 46° F. The above temperatures are taken from San Lorenzo, and are from 4° to 5° higher than at corresponding elevations on the western slopes of the main Sierras. The frost line varies with the season and the exposure, but is probably somewhere near 11,000 feet. The lowest average limit of snow is somewhere near 16,000 feet, rising on the southern exposures during the dry season to 17,000 or even 17,500 feet, and dropping down to 15,000 in the sheltered valleys of the north slope. There are times during the dry season when heavy falls of snow occur as low as 13,000 feet, but this snow never lasts more than from twenty-four to forty-eight hours, usually falling during the night and melting during the following day. On the north slopes of the mountains there is a far greater humidity and lower temperatures than on other slopes at corresponding elevations. The climate at Pueblo Viejo (2,000 feet) approximates that of 4,000 feet on San Lorenzo and the west slopes, while that of San Miguel (5,500 feet) corresponds closely with that of the Cerro Quemado de San Lorenzo, which has an elevation of 8,000 feet. These differences in conditions on the north slopes apparently exert a powerful influence on plant and animal life on that side, causing a corresponding descent in altitudinal distribution. At Don Diego the heavy mountain forest extends down to the very edge of the narrow coastal plain, and the upper foothills fauna descends with it, literally squeezing out the lower foothills forms from this region or forcing them to mingle with those of the coastal plain fauna below.

There are two distinct and well-marked seasons, the rainy and the dry, the former covering the months of April to November, inclusive, over the greater part of the mountains from 3,000 feet upward. Below 3,000 feet the seasons of rain are retarded or extended by local conditions. On the northern side, from the Rio Frio around to the Rio Piedras, the rains do not begin before May or June, and usually are over by the end of October, while on the north side, from the Rio Piedras to beyond Dibulla, they begin as early as March, and often continue as late as the end of December. Even during the dry season the north exposure of the Sierras is refreshed by almost daily fog banks, caused by the condensation of the moisture carried by the trade winds, when they come in contact with the cool vegetation of the mountain slopes. The great southern exposure of the Sierras receives a much smaller amount of moisture than any of the other portions, which is divided into two periods, at least in the lowlands and foothills, much resembling the seasons of the interior of Colombia. The spring rains fall

in April and May, while the greater part of June, July, and August are nearly without rain, the heavy rains coming in September and October. The cause of the scarcity of rain on the south side is, at first glance, hard to explain, but after a careful study of the topography and prevailing winds had been made a plausible explanation was arrived at. The prevailing winds are the northeast trades, which sweep in, moisture laden, from the Caribbean. The south slopes of the Sierras are, to a great extent, sheltered from these winds by the long spur ridge forming the southeast apex of the trihedron. The trade winds are low-flying, not extending, as a rule, to more than a thousand feet, or less, above the earth's surface, unless they meet with some obstacle which deflects them upward. The northeast spur ridge of the Nevada forms this obstacle, and its northern slope, covered with a dense forest of massive trees, receives the first impact of the winds, condenses the greater portion of the moisture carried by them, and then deflects them upward and over it to the south slopes of the mountains, but not until they have lost the greater part of their moisture, and little or none is left to be condensed into rainfall there. Farther to the south the winds sweep into the valley of the Rio Rancheria unopposed, and thence through to the Rio Cesar Valley, the height of land between having no effect on them, and having been thoroughly heated as they traversed the long stretch of arid wastes composing the Goajira Peninsula, they are drying winds. These strong northeast winds sweep through the great valley between the Sierra Nevada and the eastern Andes, drive back the gentle, moisture-laden land breezes from the Magdalena Valley and prevent their entrance from the southwest beyond a certain point. To the north of the southwest angle of the Sierra Nevada the moisture-laden winds from the Magdalena reach the west slopes of the Sierras unopposed and discharge their moisture there, giving an abundant rainfall during the rainy season on this side and its contiguous lowlands.

Vegetation of the Plains: The vegetation of the region under discussion is diversified. Beginning with the lowlands, we have, on the north side of the mountains, extending from the mouth of the Rio Piedras to a point beyond Dibulla, a heavy growth of forest, consisting of large, tall trees and very little tangled undergrowth, which extends almost to the sea beach. This may be strictly termed a humid tropical forest, but it is not jungle-like in its characteristics. Beyond Dibulla the forest gradually changes, merging first into the "dry forest," such as is prevalent around Santa Marta, and then to low, thorny scrub and cacti, prickly pear, etc. (Pl. VII.) A small, slender fan palm is abundant from Dibulla to Riohacha and as far south as Barbacoas, growing most commonly in the open parts of the scrub on low spots which are flooded during the short rainy period. This palm was not observed in any other section. Near the mouth the banks of the Rio Rancheria are clothed with mangroves, while higher up, above the influence of the tide, the same class of trees and shrubs are found which are found in similar situations around Santa Marta.

Following the trail from Riohacha southward to Fonseca, the vegeta-

tion is similar to that around Riohacha until the Rio Camarones is reached at Barbacoas, and where the foothills begin. The flood-plain of the river here is very wide in places and heavily timbered with massive trees, intermingled with dense undergrowth, while the low hills are covered with the semi-arid type of low woodland, abounding in shrubbery and small trees, the whole region showing the effect of a very low humidity. After leaving Barbacoas the trail soon begins to wind up into the foothills of the great northeast spur-range. The forest becomes heavier and heavier, with less and less undergrowth, until at an elevation of perhaps 3,000 feet the forest is composed entirely of tall, massive trees, with little or no undergrowth. This forest undoubtedly extends westward unbroken over the whole northern flank of the Sierras. The trail crosses the range at an elevation of approximately 5,000 feet, then descends to the Rio Rancheria above Fonseca. The heavy forest of the north slopes extends unbroken up to the crest of the divide and slightly over it, but there is an almost instantaneous change after crossing the crest; the dense forest of large trees gives way to an open wodland of small trees and tangled underbrush, even the species changing almost entirely.

Descending the slope, the woodland becomes sparser, acacia-like forms and cacti soon appear, and there are tracts of open savanna. Lower in the foothills and upper parts of the valley we have again the same vegetation as along the trail between Riohacha and Barbacoas. The flood-plain of the Rio Rancheria is heavily forested, like that of the Camarones at Barbacoas, except in the vicinity of Fonseca, where it has been deforested. However, as elsewhere noted, these forests of the river flood plains derive their moisture more from the subsoil rather than from the rainfall. From Fonseca to San Juan de Cesar the trail is close to the base of the foothills over a cactus- and acacia-covered plain, and the height of land separating the basins of the Rio Rancheria and the Rio Cesar is so inconsiderable that it is scarcely noticeable as one crosses it. There is but one small stream descending from the foothills between Fonseca and San Juan, and this was dry when we crossed it. The adjacent foothills are either sparsely clothed with low scrub or grass, or are bare and rocky slopes.

From San Juan de Cesar to Valle de Upar the vegetation is practically the same, except for the forests of the Badilla River flood-plain, which is very broad and well wooded. The acacia-like shrubs and trees and cacti abound everywhere else, with some slight approach to savannas in places, especially near Badilla and above the flood-plain of the Rio Guatipuri. The flood-plain of the Guatipuri is very extensive as one approaches Valle de Upar, with many canals and irrigation ditches, but on the south side of the river the land is higher and the arid woodland is largely in evidence. This same condition continues southward (at least along the trail) for about five miles, except that cacti and acacias are less abundant and other species of trees and shrubs begin to appear, and then the dry woodland changes gradually into a fairly heavy flood-plain forest which extends southwestward, with but few breaks, to a point some ten miles south of Valencia de Jesus. This is, in greater part, a magnificent lowland forest, consisting of many

large spreading trees, intermingled with smaller trees and considerable undergrowth. However, it is not properly a humid forest, since the types of trees are those of the drier woodland, developed to a more luxuriant degree, rather than those of the true humid forest, leading one to believe that the moisture, on which depends its luxuriant growth, is drawn from the subsoil rather than from the surface water of the rains. There is no doubt, however, that the rainfall is greater south of Valle de Upar than to the north of it, and these valley forests evidently extend unbroken down to the Rio Cesar and thence to the Magdalena River, because the bird fauna present here is strictly Magdalenan and very different from that to the north of Valle de Upar. This forest (along the trail) ends very abruptly at a small creek, the character of the soil changing equally abruptly, which leads me to believe that the presence or absence of luxuriant forest may be dependent to a considerable degree on the character of the soil, or, more strictly speaking, the subsoil, which I have found to be usually an extremely hard, impervious formation wherever savannas are found in the lowlands. This association of savanna and hard subsoil does not, however, hold good on mountain slopes. The savannas of the Macotoma Valley and elsewhere, I am led to believe, are the results of deforestation and repeated, systematic burning on the part of the inhabitants, rather than to any lack of humidity or nature of the soil.

As mentioned above, the flood-plain forest at Valencia ends abruptly to the west, changing to scattered clumps of low trees and tangled shrubbery, intermingled with areas of savanna. (Pl. VIII, fig. 1.) The savanna is not typical, however, as certain easily recognized and characteristic species of grasses and shrubs are absent. The whole plain from here on to Camperucho is very flat, trees and shrubs become less frequent and the tract of savanna larger and larger, until the woodland is confined to the immediate banks of the little streams which descend at rather frequent intervals from the nearby foothills. As Camperucho is approached the country becomes slightly rolling and hilly, for not far beyond here the trail crosses the last remnant of the great southwest spur-ridge. Here in this hilly country the savannas present a truly typical aspect, true savanna grasses and shrubs being present.

Soon after leaving Valle de Upar the trail again approaches the very margin of the foothills which rise abruptly from the level plain, a peculiar characteristic noted from the time we left Fonseca. From here on to Camperucho the trail is never far from the foot of the hills which present the same barren aspect all the way across from Fonseca. Higher up savannas abound, but from about 3,000 feet down little or no grass is present, except for scattered areas, while the narrow valleys and ravines and lower slopes of the valleys are slightly wooded.

Soon after entering the savanna district, south of Valencia, numerous large palms began to appear, becoming more and more numerous until we were traveling through a veritable forest of giant palms growing out of clean, open savannah. This same palm, locally known as "Coroso," is abundant over the whole western lowlands as far as Santa Marta, growing

up to an elevation of about 1,000 feet, but never *naturally* in open savannah. In fact, the seeds will not germinate except in damp, shaded places, such as in the shade of the forest. Since these palms are so abundant over practically all of the savanna areas between Valencia and Camperucho, it leads one to believe, together with other facts, that these savannas are not natural, but also the result of deforestation and burning, partly intentional and partly accidental, of a drier, more open class of woodland, which, growing over a very hard, impervious subsoil, would not readily reproduce itself after having once been destroyed. The argument that the palm would have been destroyed by such fires is erroneous, because this palm was seen in many instances burned around the base so deeply that not half of the original volume of the trunk was left, yet the trees were still luxuriant and strong and bearing as large seed clusters as the unburned individuals.

After crossing the savanna-clad hills of Alto de las Minas, we dropped down abruptly into another and distinct region of forest. In some places it was damp and dense, but for the most part it was rather light and open, with much tangled undergrowth. The country is more undulating, the soil more gravelly and less fertile, conditions which continue from Alto de las Minas to the Fundacion River, except in the small valleys and on the great flood-plain of the Rio Ariguaní. The forests of the Ariguaní are truly magnificent, consisting of gigantic trees and a sparse undergrowth; they are dense and gloomy, even at mid-day. Typical humid forest types of birds prevail, and one is reminded of the forests of the Sinú, lower Atrato, and eastern Panama and Costa Rica. Giant creepers and lianas and the peculiar parasitic fig tree abound, although epiphytes are not particularly abundant. The foothills, from Alto de las Minas northward, are also clad with a forest which extends unbroken upward. From the Fundacion River to a point slightly north of Rio Frio the lowlands were originally clothed with luxuriant humid forest, but this has been nearly all cleared away between the lower edge of the foothills and the swamps which extend back from the Cienega Grande for many miles, while vast banana plantations and pastures have taken its place. The original forest here was in many parts very similar to that of the Ariguaní, but not so heavy, I imagine, and with more undergrowth and wild plantains. Just beyond the Rio Frio there is again a very abrupt change from fertile banana farms to desolate salt plains covered with a scanty growth of acacia scrub and cacti, with a great deal of a peculiar salt-bush, common at Riohaca and between Donjaca and Gaira, near the sea beach. Soon after crossing the Rio Cordoba the same class of dry, thorny, scrubby woodland appears which was so common around Riohacha and between Valle de Upar and Fonseca. This condition continues on to Santa Marta (Pl. I, fig.2) and around to the Rio Piedras, but extending here to a considerable extent up over the lower foothills to nearly 1,000 feet in many places and much more in others, especially on the ridges. The valleys of the streams are well wooded, however, and the acacias are less abundant than on the east and south sides of the Sierras. The shores of the Cienega Grande are all low and swampy and flooded for a long distance inland during the period of high water on the Magdalena

River, while the outer fringe of vegetation is largely composed of mangroves. It is a paradise for water fowl, while many shore birds are present on the sandy strip between the lagoon and the sea and on the open wastes around the town of Cienega.

Foothill Vegetation: The vegetation of the foothills presents few abrupt changes, excepting those on the south side, which have already been described. The hills on the north side, from Rio Piedras to far beyond (northeast) Barbacoas, and those on the west side from Alto de las Minas to the Rio Cordoba, are heavily forested, much more heavily, however, on the north side than on the west, where the forests of ridges between the valleys have a tendency toward the "dry forest" of the foothills around Santa Marta. (Pl. III, fig. 1.) This foothill forest is composed of medium-sized trees, with much tangled undergrowth (except on the north side), and contains many deciduous trees, which remain bare during the dry season and thus give the undergrowth a chance for more extensive development.

On the whole, the foothill forest is most uninteresting. It contains very few epiphytes, very few lichens, and almost no moss, the only redeeming feature being the many beautiful ferns in the damper, more shaded parts. It is choked with vines, brush, and bamboo grass, is difficult to penetrate, and contains very few characteristic species of birds, mammals, or reptiles. This condition extends upward from 1,500 to 2,500 feet on the northwest and western sides, the higher elevation corresponding to the narrow ridges and the lower to the valleys. At these altitudes a gradual change takes place and the foothill woodland merges into the mountain forest. On the north slope this change is less apparent, the mountain forest, by reason of the greater humidity, extending down over the foothills for the most part practically to the edge of the costal plain, but the foothill area is, nevertheless, largely devoid of mosses and lichens and epiphytes, which nowhere appear abundantly until the lower edge of the "cloud zone" is reached.

Mountain Forest: At about 2,000 feet a marked change is noticed in the character of the forest. Deciduous trees disappear almost entirely, ferns become very abundant on north and west slopes, and a few bromeliads and orchid-like plants appear high up in the tops of the trees. The trees become gradually taller, more slender, and set closer together. Certain distinctive lowland and foothill types disappear altogether, to be replaced by others. At about 3,000 feet a slender, graceful palm known as Maquenque, puts in its appearance, and the underbrush changes from wiry brush and bamboo grass to a low, broad-leaved palm and to more succulent types of shrubbery. Lichens are now abundant on many species of trees, while bromeliads are more common and lower down. From 3,000 feet up to 6,000 feet there is little change in the vegetation, merely in the diminishing or disappearance of some species and the increase or appearance of others, but the types remain about the same. Between 4,000 and 6,000 feet the trees seem to attain their maximum development, and truly magnificent forest areas are present at these altitudes under favorable soil and slope conditions. The

Maquenque palm, so common lower down, disappears at 5,000 feet, but the low, broad-leaved species, "Cola Gallo," becomes more abundant, so that in many places it forms almost the only undergrowth present. On the northeast slopes of the Sierras, also on San Lorenzo and the Horqueta, there is a most unusual development of tree moss in the cloud zone. Between 6,000 and 8,000, or even 9,000 feet, these slopes are drenched with rain or cloud mist almost daily, and as a consequence this moss attains such a growth as to choke out most of the smaller epiphytic growth, only the hardier Bromelias being able to withstand it. Not only the trunks of the trees are solidly carpeted with it, but the branches and even slender twigs are completely enveloped with close-set filaments from one to three inches long. (Pl. II; Pl. III, fig. 1; Pl. IV, Pl. V.)

A magnificent palm, resembling the Royal Palm, is also abundant on the north slopes between 4,500 and 6,000 feet, appearing often in large groves, the great plume-like tops towering above the other forest growth. Above 6,000 feet the size of the forest trees gradually diminishes, except in sheltered valleys. Bromeliads and orchids become more abundant in individuals and species and now grow low down on the trunks of the trees as well as on the branches. Four very distinct species of bromelias were noted on San Lorenzo between 5,000 and 8,000 feet. At 7,000 feet the type of forest growth changes rapidly, giving way to trees of a hardier character, many with small, close-set leaves of dark, glossy green. They are not so tall, more branching, and less symmetrical in shape. Different types of undergrowth also appear. Bamboo grass and bamboo cane become the dominant undergrowth in many places, often completely choking out every other variety of smaller growth. Such tracts of bamboo grass and cane are nearly impenetrable, except by the hardest kind of cutting with a machètè, and they contain little in the way of animal life. At about 7,000 to 7,500 feet and upward as far at least as 9,000 feet, on all open or exposed ridges, especially those which have been burnt, a peculiar large bromeliad with great recumbent stalks grows along the ground. (Pl. VI.) These plants harbor many species of amphibians and insects and hold a considerable amount of water in their crowns, even through the dry season. Coarse brake ferns of several species are abundant, especially where fire has passed, extending from 4,000 to 8,000 feet or more. Countless species of smaller ferns abound at all altitudes, from 1,500 feet to timber-line, from the most delicate of maidenhairs to the great tree ferns. There are also present on San Lorenzo, from 7,000 feet upward, great numbers of an exceedingly tall and slender palm, known locally as the "wax palm," and apparently very similar to, or identical with, the palms which are so abundant in the central Andes in the vicinity of Quindio Pass. I have no recollection or note of the presence of these palms in the Sierra Nevada proper. From 7,000 feet up to timber-line there is little change in the types of vegetation, certain species of trees and shrubs disappear, to be replaced by others of similar type. The trees, however, become lower and more branching, and on exposed ridges are gnarled and twisted, while nearly all are smothered in masses of many curious forms of epiphytes, mosses, and lichens. At timber-line the change

from low forest to open moorland is sometimes very abrupt, though as a rule gradual, the trees becoming smaller and smaller and gradually giving way to shrubbery and bushes intermixed with coarse grasses.

Paramo Vegetation: The immense *paramos* or moor-like tracts of land extending from timber-line to the perpetual snow present many curious types of plants. Naturally the prevailing vegetation is grass, of many species, but numerous varieties of bushes and shrubs are present, as well as many kinds of annual flowering plants of considerable beauty and bright colors. The most peculiar and characteristic form of the *paramo* is the great mullein-like plant known as "Frailejon," of which there seems to be but one species in the Sierra Nevada de Santa Marta, three very different varieties being found in the Sierra Nevada de Chita, in the eastern Andes. The leaves as well as the stalk are thick and woolly. In favorable spots it attains to a considerable size, but I never found it more than five to six feet high in the Santa Marta Mountains. In the eastern Andes it is often seen growing from fifteen to eighteen feet in height, with the trunks from eight to ten inches in diameter. The flower buds are enclosed in a mass of silky wool, of a pale greenish yellow, or golden yellow, very beautiful just as they begin to open, of large size and in clusters of four to eight. Humming-birds feed almost exclusively on these flowers in season, especially Oxypogon, while the seeds furnish the bulk of the food for the many sparrows of the *paramo*.

Mountain Savannas: Great tracts of savanna are present on the southern slopes of the Nevada and on the north slope in the Macotama and Rio Ancha valleys, also to a lesser extent in the Palomina, all more or less above 2,000 feet. The cause of these savannas has been a debated question and has not, I believe, been satisfactorily explained in many cases. It is a practical certainty that where such savannas occur above 2,000 feet and are in a zone belonging to, or surrounded by, a forest belt, such as those of the north slope, they are due to deforestation and persistent burning. The fact that in regions of extensive savannas the rainfall and consequent amount of humidity is less is an effect of, rather than a cause for, the presence of the savannas, because the absence of forest growth always lessens the amount of atmospheric condensation.

Colombia is a country which has been populated in certain sections for many years, and the valley south of the Sierra Nevada de Santa Marta is one of the oldest of these, it having been settled early in the sixteenth century. The town of Valle de Upar was founded before the colonization of North America began. Deforestation and systematic burning, covering a period of from one to four centuries, must inevitably destroy large areas of forest, while the natural flora to follow in such cases would be the hardy grasses which constitute the vegetation of the present savannas. Several instances tending to prove this theory have come under my personal observation, covering a period of but nine years, so that if obvious results can be obtained in that short time, what might not take place in a period covering several centuries. Not only have the southern slopes of the Sierra

Nevada been settled by the Spaniards and their descendants for nearly four hundred years, but they found there upon their arrival a large population of Indians, living largely by agriculture, the remnants of which still exist on those southern slopes and in the three valleys of the north slope which today show large areas of savanna. It is an absolute certainty that the savannas on the north and west slopes have been caused entirely by deforestation and burning done by the Indians. I am also inclined to believe that the southern slopes of the Sierras were at some time forested to a much greater extent than at the present day and that their present barren condition has been brought about largely by deforestation and burning. A mountain savanna when once started, and burned over every year at the end of the dry season, will spread very rapidly, for with each burning the surrounding woodland is killed for distances varying with the character of the underbrush and the steepness of the slope, the fire often running up a steep slope through the forest for miles before dying out. The Colombians as well as the Indians invariably burn over the savannas every year, just before the spring rains, to remove the hard, woody grass stems and to stimulate the growth of tender fresh grass for their livestock. It is probable that the original forest growth of the southern slopes was not dense owing to the lesser amount of precipitation there, brought about by natural topographical conditions, as elsewhere explained, and for this reason was the more readily destroyed by fire. Once destroyed, its replacement was an impossibility, owing not only to repeated burnings but to diminishing rainfall, due to the absence of woodland. Probably the most striking confirmation of the recent formation of savannas at the foot of the southern slopes, is the fact that there is an *entire absence* of any reptilian or amphibian fauna peculiar to natural savanna, all the forms taken on these savannas being the same as those present in the surrounding and adjacent forest or scrub.

General Character of the Faunas, Mammalian and Avian: Taken as a whole, the fauna, especially the bird fauna, of the Sierra Nevada de Santa Marta, is not an abundant one, as represented either by species or individuals, when compared with that of many parts of the Colombian Andes. The great group of fruit-eating tanagers, so abundant in all three ranges of the Andes, is conspicuously absent here, but three species of Tanagra being found from sea-level to timber-line. Buthraupis and Compsocoma are entirely absent, while Poecilothraupis and Ramphocelus are represented by but a single species each. The other great fruit-eating groups, the parrots, toucans and trogons, are also poorly represented from the foothills upwards. Parrots are abundant in the lowlands of the west and parts of the south side. In the mountains proper but four species of parrots, two of trogons and three of toucans are found, which is a mere bagatelle as compared with the Andes, especially the parrots. This undoubtedly shows that the forest growth, which is very different from that even of the eastern Andes, offers little in the way of fruits and berries. On the other hand, insectivorous forms are more abundant, especially the Dendrocolaptidæ and Formicariidæ. Hummingbirds are also poorly represented everywhere, and present in small numbers, with the exception of a few

very hardy, wide-ranging forms of the lowlands. However, above 4,000 feet there are not more than about a dozen species of Trochilidæ, a very poor showing as compared with either range of the Andes. Monkeys are rarely seen above 2,000 feet, and very uncommonly above the costal plain. In Venezuela I have taken Mycetes up to 7,000 feet, where it was apparently not rare, according to local report.

Among the mammals, the wild pigs and agoutis are the most abundant, ranging from sea-level to at least 8,000 feet. Tapirs are fairly common above 3,000 feet. Deer are nowhere common, except the large species found in the delta region of the Magdalena, which in reality hardly belongs to the region under discussion. Rodents and squirrels seem to be abundant nearly everywhere up to at least 6,000 feet, as well as marsupials and foxes; the latter, however, are not, as a rule, seen above 2,500 feet, although I saw a pair at Vista Nieve at 5,000 feet.

A description of the amphibian-reptile fauna is given by Dr. Ruthven.

Conclusion: The great inaccessibility, solitude and isolation of the Sierra Nevada de Santa Marta have been the chief causes of the fragmentary nature of the biological work done there, and until better means of travel and communication have been opened up there are numerous large areas which will remain unexplored and unknown. A few regions, such as Mount San Lorenzo and the Horqueta, which are easy of access, have been intensively worked along several lines, and certain accessible portions of the lowlands may easily be studied, especially the banana district. However, the bulk of the region, both lowlands and highlands, is accessible for intensive biological study only by means of well-equipped expeditions with considerable time and money at their disposal. Such expeditions could, however, be easily organized and carried out by the combined efforts of several large and well-equipped scientific institutions, each one furnishing one or two experts in certain branches of biology, and bearing its corresponding quota of the expenses. Such expeditions, under capable leadership, and composed of men accustomed to work in the tropics or other wild and uninhabited regions, could obtain important results, and there would be no duplication of field work, with consequent loss of time and money. There is probably no other portion of the American tropics which today offers such a promising field for intensive biological study as the Sierra Nevada de Santa Marta. The work already done has been entirely too fragmentary and widely separated to lead to many definite general conclusions, especially concerning such broad problems as faunal origin and relations. Too much mere reconnaissance and too little intensive study of life history and distribution have been done. In the present sketch (for with our present knowledge it can be classed as nothing more than a sketch) there has been little attempt to arrive at many definite conclusions. An attempt has been made to set down the facts as known to the author, with the hope that they may stimulate further work in this most interesting field and serve as a basis for intensive study.

List of Localities Referred to by Simons, Brown, Smith, Carriker, and the University of Michigan Expeditions.

Alto de las Minas. Point on the trail between Valencia de Jesus and Fundacion, where it crosses the lower extremity of the great southwest spur ridge of the Sierra Nevada. Probably not more than 600 feet above sea-level, and three days' journey from Fundacion.

Ariguaní. A cattle ranch of considerable extent which has been opened up on the Rio Ariguaní at the point where the Valle de Upar trail crosses it. It is in the heart of the great lowland forest, about thirty miles south of Fundacion, and at no great distance from the lower edge of the foothills.

Aqua Dulce. Plantation on San Lorenzo, altitude about 3,000 feet.

Arroyo de Arenas. A cattle ranch and regular stopping place for pack trains and travellers journeying between Riohacha and Fonseca. It is a long, hard day's march from Riohacha, and the first point at which good water and forage can be obtained. It lies at the edge of the flood-plain of the Rio Camarones (called Barbacoas here) and is probably about 500 feet above sea-level. Outside of the flood-plain forest the vegetation consists of low woodland of the dry forest type, acacias and cacti being conspicuous.

Badillo. Once a flourishing little town, but now a miserable collection of huts, situated on the trail between Fonseca and San Juan de Cesár, and near the Badillo River. To the southwest of the town lies the heavy woodland of the river flood-plain, while to the north the vegetation consists of dry acacia-like scrub and cacti, interspersed with patches of open savanna-like areas. The foothills are but a few miles distant.

Barbacoas. A tiny hamlet at the crossing of the Rio Barbacoas, about two miles south of Arroyo de Arenas.

Bolivar. A small farm and lowland station of the Santa Marta Coffee Company, from which pack mules start for the *hacienda* Cincinnati. It is about five and a half miles from Santa Marta, a mile and a half from Mamatoco, and about 100 feet above sea-level. The prevailing vegetation, outside of the irrigated areas, consists of low, semi-arid woodland, acacias and cacti. The nearby Jamonacá Creek Valley is rather heavily wooded and offers good collecting ground.

Cacagualito. A small farm, now abandoned, at which Mr. Smith collected. It lies on the trail between Bonda and the north coast, by way of the Quebrada Jordan and the Rio Piedras. It is between 800 and 1,000 feet above sea-level, on the ridge separating the valley of the Matajiro and Jordan, and lies in the foot-hills section of the semi-arid coast belt.

Camperucho. A small settlement of scattered houses on the trail between Valencia de Jesus and Alto de las Minas, a hard day's journey from Valencia. It is in a rolling, hilly region, on a remnant of the same ridge as Alto de las Minas, and not more than 400 to 500 feet above sea-level. It is largely a region of savannas and scattered clumps of scrubby woodland.

Cerros de Caracas. A broad, well-defined mountain range of the Sierra Nevada proper, beginning just below San Miguel, at the Rio Macotama, at an altitude of about 5,000 feet, and rising abruptly to about 8,000 feet, then gradually to about 13,000 feet, where it ends in a jumble of jagged, naked pinnacles of rock, which form a barrier to further ascent to the snow-capped peaks above. The whole of the eastern end and southeastern flank has been denuded of forest, but the northwest side is steeper and forested to the crest.

Chinchicúa, Valley of. A locality given by Simons as having an altitude of 6,500 feet, and situated on the south slopes of the Nevada a short distance below San Sebastian.

Chinchicúa, Pass of. Pass at head of valley of same name, having an altitude of 11,000 feet. Locality used by Simons.

Chirúa. The name of a large valley and the small stream which drains it. Situated on the northeast slopes of the Nevada, at an altitude of from 2,000 to 5,000 feet, and empties into the Rio Ancha at Pueblo Viejo. The valley is nearly enclosed by mountains rising on the south side to about 5,000 feet, known as the Heights of Chirúa. The valley is sparsely inhabited by Indians, and nearly the whole of the lower portion has been deforested in years gone by, and is now covered either with grass, low scrub, or cultivations of the Indians.

Chirúa, Heights of. The mountain ridge lying on the southwestern side of the valley of Chirúa, with an elevation of about 5,000 feet.

Chirúqua, Paramo de. The immense *paramo* lying on the crest of the Nevada to the south of the upper Macotama River and to the east of the snow peaks, with an altitude of from 11,000 to 15,000 feet. This is doubtless the *paramo* de "Curigua" of Sievers. The name Chirúqua was used by Brown, and I followed his nomenclature without taking the precaution to verify it, so that I do not know which name is the correct one. Lake Macotama, mentioned elsewhere in this report, lies at the northwest end of this *paramo,* at 15,000 feet elevation. This *paramo* may be reached either from Pueblo Viejo on the north slope or from San José on the south slope. It is easier of approach from the north side, where a good Indian trail leads from Pueblo Viejo over to the Macotama River, thence up that stream through Santa Cruz, San Miguel, Taquina, Macotama, and on up to the *paramo.* This trail is passable for oxen or a good mule, and the *paramo* may be reached from Pueblo Viejo in two days.

Cienega (formerly known also as San Juan de Cordoba). A city of between 15,000 and 20,000 inhabitants, twenty miles by rail from Santa Marta, and situated on the sea coast, just at the northeastern corner of Cienega Grande, the great brackish lake lying between the Sierra Nevada and the Magdalena River.

Cincinnati. A large coffee plantation lying on the western slopes of Mount San Lorenzo, between 3,000 and 5,500 feet. This plantation was known as Valparaiso at the time Smith and Brown collected here. It is a

fine collecting field, and has been visited by all naturalists who have come to Santa Marta. The plantation is about nineteen miles from Santa Marta, and is reached by the road leading out through Mamatoco, Tigrera and Minca.

Concha. A small bay southeast of Santa Marta, also the short creek and valley emptying into it. There is a small stock farm there belonging to a resident of Santa Marta. It is the first indentation of the coast beyond Tagánga, and the second from Santa Marta Bay.

Copéi. A stopping place for travellers and pack trains on the trail between Ariguaní and Camperucho, about fifteen miles south of Ariguaní. It is in the heavy lowland forest.

Corazones. A little hamlet near Valle de Upar, between that town and Badilla, and not far from the Rio Guatipuri. It lies just between the Guatipuri flood-plain forest and the dry scrub of the open country.

Dibulla. A squalid village on the coast about half-way between Santa Marta and Riohacha, and about three miles east of the point where the trail leaves the coast for the Sierra Nevada, by way of Pueblo Viejo and San Miguel.

Donama. A small farm, now nearly abandoned, lying on the divide between the head of the Matagiro Valley and the Rio Piedras, at an elevation of about 1,500 feet. It is on the trail between Bonda and the plantation Las Vegas. It is just between the "dry forest" area of the Santa Marta coast belt and the humid forest of the north slopes of the Sierras, the valley of the Rio Piedras being largely in the latter zone.

Don Diego. An old plantation (now practically abandoned) belonging to a French company, and situated on the north coast at the mouth of the Don Diego River, one of the largest rivers draining the north slopes. There is a trail leading to it from Santa Marta, going out by way of Mamatoco, Bonda, Calabaso, Jordan, thence down the Rio Piedras to the coast, and then following the beach. This trail is almost impassable through disuse and lack of repair. The place is much more easily reached by sea from Santa Marta. The region around Don Diego is heavily forested, has a heavy rainfall and is very rich in animal life.

Donjaca. A flag station and passing point for trains on the Santa Marta Railway between Gaira and Cienega. It is on the coast, and lies in the semi-arid coast belt of scrub and cacti.

El Líbano. A name used by Mr. Smith for a point on the northwest slope of San Lorenzo with an altitude given by him of 6,000 feet. It is in the upper part of what is now known as the plantation of La Victoria, which adjoins Cincinnati on the east. Conditions are practically the same as around Cincinnati.

El Lorenzo (see San Lorenzo).

El Mammón. A locality at which Mr. Brown collected in the Sierra Nevada, and given by Dr. Allen as having an altitude of 8,000 feet. It is on the south slopes of the Sierras, a short distance above San Sebastian.

Fonseca. A small town on the Rio Rancheria a few miles below the point where it breaks out of the foothills into the valley lying between the Sierra Nevada and the eastern Andes. I do not think it can be more than 500 feet above sea-level. Except for the heavy woodland of the Rio Rancheria flood-plain, the surrounding country supports a vegetation very similar to that encountered all along the trail between Riohacha and Arroya de Arenas, viz., low open scrub of acacia-like trees and cacti. It lies on the main trail between Riohacha and Valle de Upar.

Fundación. A large cattle ranch and travellers' station on the trail between Camperucho and Alto de las Minas, on the Rio Garupal. The prevailing vegetation in the immediate vicinity is savanna and scattered clumps of low, tangled woodland, largely of the "dry forest" type.

Fundación. A small village at the southern terminus of the Santa Marta Railway. The name Fundación really applies only to that portion of the town lying on the north side of the Rio Fundación, which has been built up since the railway reached that point. The part of the town on the south side of the river is the old settlement existing before the arrival of the railway and was called Buena Vista. This name is still used by the inhabitants of the region to the south, but as a rule the name Fundación is now used everywhere for the town as a whole. The country to the south and west of the town is broken and hilly, with a more open forest in which many types of trees belonging to the "dry forest" are present. To the west and north the forest has been largely cleared away, but was originally of the heavy, humid type, similar to the Magdalena basin and the Ariguaní.

Gaira. A small village on the Santa Marta Railway about eight miles from Santa Marta and not far from the sea. With the exception of the land under irrigation and the narrow valley of the Rio Gaira, the whole region is very arid, with an abundance of thorny scrub and giant cacti.

Guallabol or *Guayabol.* A locality given by Simons, and which I cannot locate definitely. It is given as having an elevation of 3,000 feet, and must be somewhere on the south slopes of the Sierras, since there is no such place on either the north, northwest or west sides.

Jordan. A locality used by Smith. It is situated on a small stream of the same name, which empties into the Rio Piedras, and lies between the Matagiro Valley and the hills along the coast east of Santa Marta. The head of the valley is in the semi-arid coast belt, while the lower portion is heavily forested like the valley of the Rio Pedras, being really in the transition zone between the semi-arid and the humid of the north coast. It is reached by the trail out from Bonda, which leads to the coast at the mouth of the Rio Piedras and thence to Don Diego and Dibulla.

La Concepcion. A locality used only by Brown, and given as having an altitude of 3,000 feet. It is always given in connection with localities on the north slope, and from the species listed as taken there I would judge that it was on the top of the mountain ridge which the trail crosses in going from Pueblo Viejo to San Miguel.

Las Flores. A small farm and lowland station belonging to the *hacienda*

Vista Nieve. It lies on the cart road between Mamatoco and La Tigrera, about a mile from the village of Mamatoco and five miles from Santa Marta.

Las Nubes. A coffee plantation on the northwest slopes of the mountain known as La Horqueta, adjoining San Lorenzo on the north. The mountain has an elevation of about 7,000 feet, while the dwelling house of the plantation is at about 5,000 feet. It is reached by the road running out from Mamatoco through Masinga. The local conditions are about the same as around the *hacienda* Cincinnati. Mr. Smith did some collecting here.

Las Pavas. A small hamlet and travellers' station on the trail between Alto de las Minas and Copéi, on the Fundación-Valle de Upar road. It is at the point where the heavy lowland forest begins, after dropping down from the highlands of Alto de las Minas.

Las Taguas. A point lying on the south slope of San Lorenzo Mountain at an altitude of about 5,000 feet, at the head of the Valparaiso Valley. The stream is a tributary of the Rio Cordoba, which empties into the sea near Cienega. It is a heavily forested, humid region, and has been visited only by the writer and the University of Michigan expeditions.

Las Vegas. A coffee plantation situated on the northeast slopes of a long spur ridge of the Horqueta Mountain, near the headwaters of the west branch of the Rio Mendaguaca. It lies between 3,000 and 5,000 feet in a region of heavy humid forest peculiar to the north slopes of the Sierras. A locality at which only the writer has collected.

Loma Larga. Name of a small region of scattered small farms and travellers' stations on the trail between Riohacha and Fonseca, and situated about fifteen miles south of Arroya de Arenas. It lies in the foothills of the great northeast spur range of the Sierras and is heavily forested except where clearings have been made. The altitude is probably about 2,500 to 3,000 feet. Visited by the University of Michigan Expedition in 1920.

Macotama. At present but a tiny Indian village, but formerly the tribal centre of the whole Arahuaco population of the north side of the Sierras. It is still the place of residence of the chief "medicine man" or "doctor," as the Indians call him. It lies in the valley of the Rio Macotama about ten miles above San Miguel. The village itself does not have an altitude of "8,000 feet" as given by Bangs, but the mountains rise on either side of the valley to a height of from 11,000 to 12,000 feet. The elevation of the village itself is about 7,000 feet. There is no forest left in the valley here, except a tract on the east side, which has been largely cut over by the Indians. A few trees and scattered shrubbery remain along the river itself and in the ravines. The village lies on a shelf on the right-hand side of the river, ascending, and the mountain on that side is clothed only in grass as far as the eye can reach, with rarely a clump of low bushes. Visited by Mr. Brown and the author.

Macotama, Paramo de. I have applied this name to the *paramo* on top of the range to the east of the village of Macotama, and which extends southward to join the backbone of the Sierras at the Chirúqua Pass. I am

quite positive that this is also designated by Mr. Brown as the *paramo* de Macotama. This *paramo* does not attain an elevation of more than 12,000 feet and has less shrubbery than the Chirúqua *paramo*.

Mamatoco. A small village four miles east of Santa Marta, on the Manzanares River and on the road to Bonda and Masinga. It is less than fifty feet above sea-level, with hills to the north and east, and with flat land to the south and west, much of which is under irrigation. It is in the semi-arid coast belt.

Manzanares. A small farm and travellers' station on the trail between Valencia de Jesus and Camperucho, about six miles from Valencia. It lies in the heavy forest belt of the Rio Cesár (described elsewhere in this paper) and is rich in animal life of all kinds. The University of Michigan Expedition spent several days here.

Marocaso. One of Mr. Simons' localities, at an altitude of 2,000 feet, near the Rio Rancheria, on the south slopes of the Sierras. (According to Dr. Allen.)

Masinga or *Masinga Vieja*. A small hamlet about ten miles from Santa Marta in an easterly direction. It is on the Manzanares River about two miles above Bonda, and presents the same conditions as at that place. Mr. Smith collected extensively here.

Minca (misspelled Minea by Salvin and Godman). An old, abandoned sugar plantation in the foothills at 2,000 feet elevation, and about fourteen miles from Santa Marta on the road to the *hacienda* Cincinnati at the point where it crosses the Rio Gaira, but not near the head of that river, as stated by Dr. Allen. It is more or less in the transition zone between the "dry forest" of the lower foothills and the mountain forest, but more inclined to the latter. Many small clearings have been made in this vicinity during the past three years. Collections were made here by Simons, Smith, both expeditions from the University of Michigan, and by the writer.

Naranjo. A locality mentioned by Mr. Smith, and situated on the Rio Piedras just below its junction with the Rio Jordan. Altitude about 500 feet.

Onaca. A coffee plantation near Las Nubes, but lower down on the mountain slope and more to the north. Altitude given as 2,500 feet. Mr. Smith collected here, but the writer has never visited it. It is reached by the trail leading out through Masinga.

Palomina. An Indian village on the north slopes of the Sierras, on the river of the same name, and at an altitude of 5,000 feet (as given by Mr. Brown). There is a small hamlet on the coast at the mouth of this river which must not be confused with the Indian village at which Mr. Brown collected. I did not visit this locality, but according to all authentic reports which I have been able to gather it has been but slightly deforested, there being but a small area of savanna here.

Paramo (see Chirúqua and Macotama). A word here as to just what is meant by a *paramo* may not be out of place. It is that portion of the high mountain ranges of the tropics which lies between timber-line and the

snow-line or the crest of the range, as the case may be, with a minimum altitude of more or less than 10,000 feet, but varying considerably in different regions. In the eastern and central Andes of Colombia there exists a heavy "temperate zone" forest which extends up as high as 12,000 feet in many places, but this forest is absent in the Sierra Nevada de Santa Marta, where *paramo* conditions begin at about 10,000 feet. The lower parts of the *paramo* contain more or less of an abundance of small gnarled trees and shrubs intermingled with bushes and coarse grass, the greater the quantity of moisture present the more abundant the shrubbery. As the altitude increases the gnarled trees disappear, the shrubs become more stunted, the bushes lower and tougher, while the grasses increase. Certain species of hardy little bushes persist to the very snow-line, as well as the "Freilejon."

Pueblo Viejo. A village whose inhabitants are entirely Colombians, situated on the north slopes of the Sierras at an altitude of 2,000 feet, on the Rio Ancha, several miles above its confluence with the Rio Macotama. It is nearly a two days' journey with pack animals from Dibulla over a trail not of the best. It is just at the edge of the "Indian country," few or no Indians living below this point.

Pueblo Viejo. Another village on the south slopes of the Sierras, not far from San Sebastian, with an altitude of 8,000 feet (as given by Dr. Allen). This locality must not be confused with the preceding, since conditions between the two are entirely different. The country around the present village is largely savanna.

Pueblo Viejo. There is a third village known as Pueblo Viejo which should be mentioned here, although it does not appear in scientific literature, but it might be confused with the two preceding localities by future collectors. It lies on the narrow spit of land separating Cienega Grande from the sea, a short distance to the west of the town of Cienega, and at the point where the Cienega Grande empties into the sea.

Punto Caiman or *Playa Caiman.* A point on the coast of Salamanca at the northwest corner of Cienega Grande. The coast of Salamanca is the narrow strip of sand which separates Cienega Grande from the sea, and is nowhere more than two or three miles wide. It is covered in many parts with shrubbery and small trees, while the Cienega shore is thickly populated with mangrove, with only an occasional open beach. Water birds are abundant, also several small land birds. The most abundant animals here are the omnipresent mosquito and sand-fly, which make life a misery at all hours of the day and night. Visited once by the writer, who trusts that the visit will never have to be repeated.

Quebra Concha (contraction for Quebrada Concha). The small creek draining the Concha Valley and emptying into Concha Bay.

Quebra Mojada (Quebrada Mojada, spelled by Dr. Allen "Mojaba"). A small creek flowing into the Manzanares River about midway between Mamatoco and Bonda, and dry most of the year. Mentioned by Smith.

Riohacha. A town of about 5,000 inhabitants on the north coast about

ninety miles from Santa Marta to the east, and the metropolis of the Goajira Peninsula. It lies about a mile to the west of the Rio Rancheria (or Calancála, as it is called here), which river is the dividing line between the Departamento de Magdalena and the Territory of the Goajira. It is reached only by sea from Santa Marta, the trail by land being impossible of consideration. The sole means of transit are small schooners, which leave much to be desired in the way of accommodations, and to persons who are poor sailors this trip is a veritable torment in the windy season. The vegetation of the surrounding country is a low, thorny scrub, containing many acacia-like forms and an abundance of cacti of various species. It is exceedingly dry for the greater part of the year and the heat is terrific. However, from the standpoint of the naturalist it is an exceedingly interesting region, introducing as it does a fauna quite distinct from that of any other part of the region under discussion.

San Antonio. This is the old Indian village, now non-existent, which lay about three miles to the south of the present village of Pueblo Viejo (the first mentioned in this list). It was destroyed by the government soldiers in the late Colombian revolution because some of the Indians had been persuaded to take up arms with the revolutionists. Its inhabitants were scattered among the Indian hamlets higher up in the Sierras.

San Juan de Cesár. One of the most flourishing towns of the valley, lying to the south of the Sierra Nevada and situated on the river of the same name (Rio Cesár). It is about a half day's journey to the southwest of Fonseca and in the same arid belt of thorny scrub as the latter place. From here the road branches, one branch passing by way of Villanueva and the other by way of Badilla, but uniting again at Valle de Upar.

San Francisco. A small Indian hamlet in the valley of the Rio Ancha about six miles above Pueblo Viejo (on the north slope of the Sierras). The mountain slopes on both sides of the valley are bare of forest, especially on the right-hand side (ascending), where the slopes are very precipitous and rocky. On the left-hand side the higher slopes are still wooded for a considerable distance. Visited by Mr. Brown and the writer.

San José. An Indian village on the south slope of the Sierras, on the trail between Atanquez and the Chirúqua Pass. According to Simons, the only collector who has visited it, it has an altitude of 5,000 feet.

San Lorenzo. A huge, isolated mountain peak lying to the northwest of the main Sierra Nevada, but connected with it by a ridge having a minimum elevation of about 5,000 feet. The whole mountain down to the foothills is densely forested, except where it has been cleared for purposes of cultivation. This forest is heavier and more humid on the east and south slopes. The crest of the mountain is in the form of a sharp ridge running nearly east and west for a length of six to eight miles. The western end, known as the Cerro Quemado, has been largely deforested by fire during the last twenty years, and has an elevation of about 8,000 feet. The remainder of the crest is forested to the very top, while the eastern end attains an elevation of a little over 9,000 feet. All the collecting done by Mr.

Smith here was on the western slopes of the Cerro Quemado up to perhaps 7,000 feet, which would account for his failure to secure quite a number of species found near the top. The vegetation of this mountain has been described elsewhere. The summit is reached by trails running up from the *haciendas* Cincinnati and Vista Nieve.

San Miguel. The largest village and the headquarters today of the Arahuaco Indians of the north slopes of the Sierras. It is situated on the right-hand side of the Macotama River (ascending), at an altitude of 5,500 feet, on a small, bench-like plateau jutting out from the mountain side about 200 feet above the river. The mountain rises abruptly behind it to the west to an elevation of not less than 9,000 feet, and is entirely bare of woodland. Opposite the village, on the other side of the river, is a much more extensive bench. Here the Indians have many small farms of vegetables and sugar cane, while the other side of the valley is devoted to grazing purposes entirely. The mountain slope also rises very abruptly from the bench land on the east side, and is wooded up to near the crest, which is overgrown with shrubbery and huge bromelias. Mr. Brown made San Miguel his headquarters for some time, as did also the writer.

San Sebastian. A village, largely of Indians, on the south slopes of the Sierra, at an altitude of 6,700 feet (according to Dr. Allen). It is mentioned by both Brown and Simons. It is in a region composed largely of savannas.

Santa Cruz. A tiny Indian hamlet on the east bank of the Rio Macotama, between Pueblo Viejo and San Miguel, with an altitude of 3,000 feet. Dr. Allen gives the altitude as 8,000 feet, an obvious error.

Santa Marta. A city of about 10,000 inhabitants and the capital of the Departmento de Magdalena, possessing one of the finest harbors on the Colombian coast. The immediate vicinity is a semi-arid region, of little rainfall, where irrigation is the only possible means of agriculture. The natural vegetation consists of thorny scrub and cacti, except along the banks of the Rio Manzanares, where a more luxuriant flora finds a footing. A flat plain extends eastward from the town for about five miles, a considerable portion of which is poorly irrigated and mainly devoted to pasture land. To the north of this plain are rugged hills extending down the coast to the east as far as the Rio Piedras, while to the south are the foothills of San Lorenzo. One of the oldest towns in Colombia, established early in the sixteenth century.

Sierra Nevada. Evidently many of Simons' labels bear the locality name of "Sierra Nevada," with the altitude. Such localities must of necessity be on the south slopes of the Sierras, since he did little work on the side near Santa Marta, and none on the north slopes. On some of the writer's labels this designation is also used, together with the altitude, for the region immediately to the southeast of San Lorenzo, where work was done from 5,000 to 8,000 feet.

Taganga (misspelled "Tayanga" by Dr. Allen). A small fishing village

in the bay of the same name, close to Santa Marta harbor and only separated from it by a low range of hills. Name used by Smith.

Tambor Ridge (see Cerros de Caracas). This was the name used by the writer on his labels before the correct name of the locality had been ascertained.

Taquina. A small Indian hamlet nearly midway between San Miguel and Macotama, on the west bank of the river, on a beautiful large bench several hundred feet above the river bed. Mr. Brown does not use the name, which is rather strange. Just below the village a small mountain stream enters the Macotama from the west, called by the Indians Sē-kai-én, which I meant to explore, but was not able to do so for lack of time. It evidently rises in the snow, and has a lake at its source, according to the Indians.

Tierra Nueva. A point on the Rio Aracatáca about five or six miles above its mouth at the Cienega Grande. It is the first high ground met with in ascending the river—that is, ground that is not submerged by the overflow from the Cienega during the period of high water. It is a region of heavy humid forest with much tangled undergrowth.

Tigrera or *La Tigrera.* A point on the road from Santa Marta to the *hacienda* Cincinnati, about seven miles above Mamatoco. The new cart road extending from Mamatoco up towards San Lorenzo has now reached a point about four miles above La Tigrera, in the valley of the Jamonacá. Tigrera is about 600 feet above sea-level and lies in the lower reaches of the foothills, in the narrow valley of the Jamonacá.

Trojas de Catáca. A small and very unique fishing village on the edge of Cienega Grande at the mouth of the Rio Aracatáca. The houses are built on piles driven into the mud over four to five feet of water. The inhabitants subsist entirely by fishing, selling the fish in the towns of Cienega and Barranquilla. It is reached only by boat from Cienega or Pueblo Viejo.

Tucurinca. A banana plantation belonging to the United Fruit Company, on the Santa Marta Railway between Sevilla and Aracatáca, at which the writer collected.

Valencia de Jesus. A small, wretched-looking village, surrounded by second-growth scrub, about twenty-five miles southwest of Valle de Upar on the main trail which encircles the Sierras on the south side. It is in the heart of a considerable forest belt. Simons mentions this locality, while the University of Michigan Expedition did considerable collecting at Manzanares, about six miles southwest of it.

Valparaiso (see Cincinnati).

Valle de Upar (often spelled Valle Dupar, though the correct spelling is that given at the margin). The principal town of the lowland district between the Sierra Nevada and the eastern Andes. It is on the Rio Guatapuri, a short distance above its confluence with the Rio Cesár, and is one of the oldest settlements of Colombia, having been established by the Spaniards shortly after the founding of Santa Marta, early in the sixteenth cen-

tury. It has sadly deteriorated, but still shows signs of former opulence. It cannot be more than 500 to 600 feet above sea-level.

Victoria, La. A coffee plantation on the north slopes of San Lorenzo, adjoining the *hacienda* Cincinnati on the east and north. There is also another plantation of the same name near Dibulla, on the sea coast, where the writer worked some years ago.

Vista Nieve. A new plantation established by the writer a few years ago, lying on the south slopes of San Lorenzo, with lands reaching from 3,000 to 8,000 feet. A region of heavy mountain forest. It is reached by the same road leading to the *hacienda* Cincinnati, passing through that plantation and continuing on around the mountain about four miles.

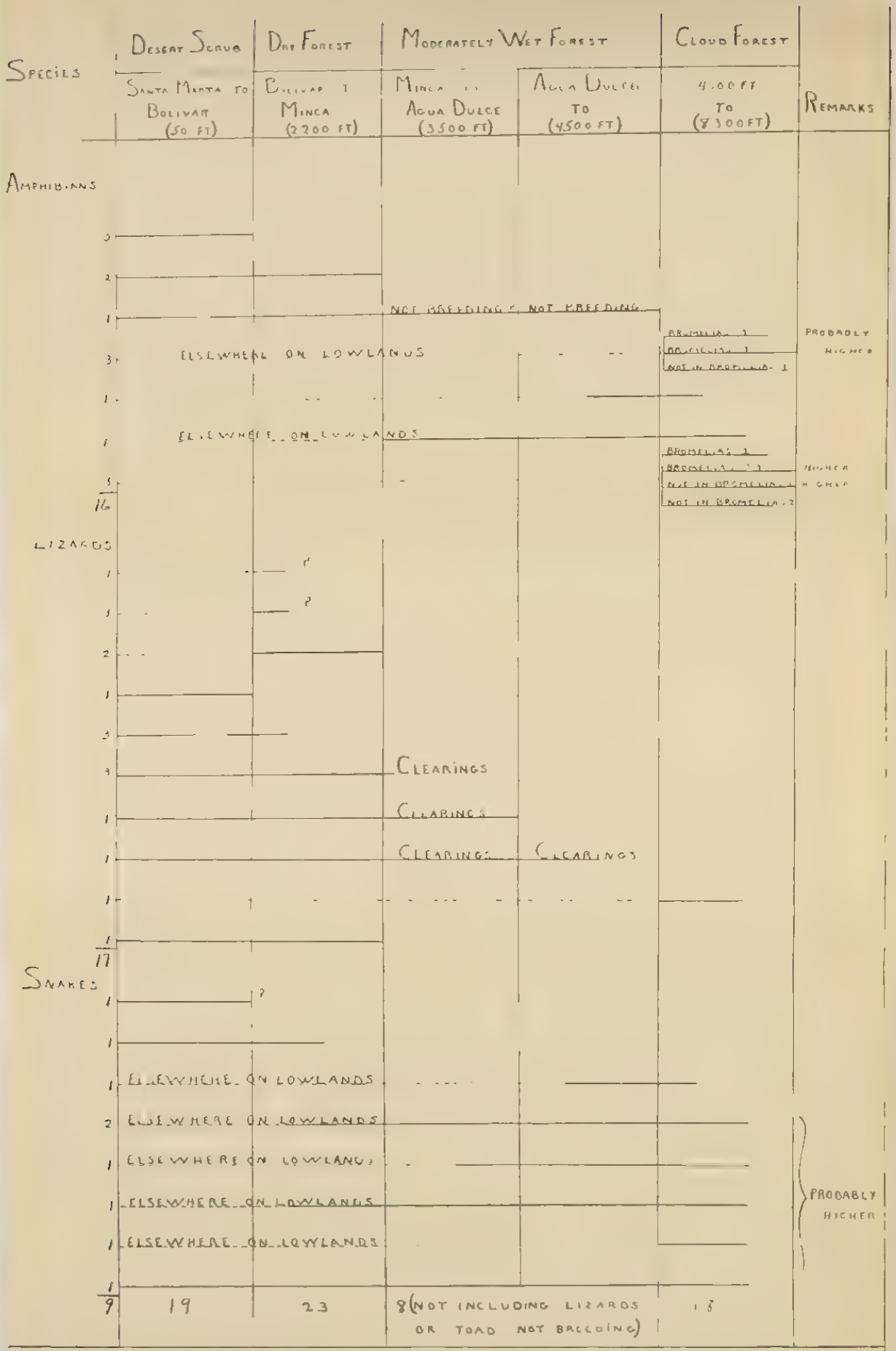
THE REPTILE-AMPHIBIAN FAUNA AND ITS GEOGRAPHICAL RELATIONS

Summary of the Known Fauna: But few zoologists have visited the Santa Marta range. Previous to 1913 only two collectors seem to have collected reptiles and amphibians in the mountains, W. W. Brown for the Museum of Comparative Zoology of Harvard College, and H. H. Smith for the Carnegie Museum, and these men gave particular attention to other groups. The published records are those of the Museum of Zoology of the University of Michigan and a paper by Lawrence Griffen[2] which includes the snakes obtained by Smith.

The writer has had the material collected by Brown and Rehn and Hebard (in 1920), through the courtesy of the Museum of Comparative Zoology and the Academy of Natural Sciences of Philadelphia, besides the specimens obtained by the expeditions of the University of Michigan, but he has been able to examine but two of the specimens of the Smith collection. The material studied represents 93 species and includes all but seven of the thirty-one snakes recorded by Griffen, if from his list are excluded four species: *Leptophis rostralis,* of doubtful locality; *Epicrates cenchria fusca,* a color variety of doubtful validity; *Micrurus columbianus,* a synonym, and *Atractus badius,* which is evidently identical with the species referred to in this paper as *Atractus irridescens.* The seven species listed by Griffen which have not been seen are *Helminthophis bondensis, Boa cooki, Leptophis bocourti, Spilotes pullatus, Oxybelis fulgidus, Rhinostoma guianense, Micrurus corallinus.*

It is very clear that much more field work must be done before the components of the fauna, the habitats, and the exact distribution of many of the species are accurately known, particularly since the records of Brown and Smith cannot be used for detailed studies. (See page 15.) It is believed, however, that the data obtained by the University of Michigan expeditions is sufficiently detailed to permit certain deductions to be made. An attempt was made to work out the breeding habits of the species, when these were likely to throw light on the distribution, and much time was spent in the field to get representatives of every species in each habitat and region and to determine the limits of range of each species. These data

[2] *Memoirs of the Carnegie Museum,* VII, pp. 163-227.



Vertical distribution of common amphibians and reptiles in the Santa Marta region

were preserved with the specimens. It may at least be said for the data that they are more detailed than those often used as the basis for conclusions upon the environmental factors in distribution.

Nature of the Materials: Although in a way a truism, it cannot too often be reiterated that any attempt to summarize the distribution of the terrestrial cold-blooded vertebrates must, to be convincing, take into account the secretiveness, the apparent rareness, and the inconspicuousness of many species which make collecting in these groups fortuitous in no small degree. It is quite obvious that these attributes of the components of a fauna make it difficult to determine with accuracy the limits of ranges, but it is too often ignored in the practice of listing species of doubtful range by habitats, zones, etc., suggested by the distribution of a part of the fauna, with the result that the faunal areas receive support from records which should not be considered adequate for the purpose. If the field work is carried on in detail and over a considerable length of time, it is possible even in the groups under consideration to reduce the species of unknown range to a relatively small number, and it would seem to be the best practice to exclude from summaries those forms so rare or secretive as to be represented in the collections only by a few specimens from one place. The exclusion of rare forms can only lead to erroneous results when such species constitute a considerable part of the fauna.

Vertical Distribution: To obtain data on the distribution of the species with altitude a detailed study of the fauna of the northwestern slope of San Lorenzo was made. The conditions on this slope are very favorable for the study of the vertical distribution of amphibians and reptiles. Located in a region which supports a large fauna in these groups, rising rapidly from sea-level to a height of 9,300 feet, and possessing great differences in climate and vegetation within the space of a few miles, it is to be expected that on this mountain the upper and lower limits of ranges will be rather sharply defined and zonal distribution, if present, conspicuous. Moreover, the region is accessible and as easily studied as such a region can be, since trails have been cut to 8,300 feet and it is possible to obtain living quarters at different elevations.

It will be clear from Mr. Carriker's description of the region that the vegetation in the San Lorenzo region changes from a desert flora to a xerophytic forest flora at about 100 feet, from a dry forest type to a wet forest type at about 2,200 feet, the latter becoming a humid jungle type above 4,500 feet. The greatest difference exists between the dry and wet forests. The plains have, or evidently originally supported a considerable growth of xerophytic trees, and above 2,200 feet, while the wet forest becomes wetter with increased altitude, the change is gradual and the flora is of about the same nature. At about 2,200 feet the change in the type of forest on the ridges takes place within a short distance. There is also at this point a marked change in the fall of the streams, so that it may be said that above this altitude there are no ponds or pools, whereas lower down these are often found in the broader valleys and on the plains. It is possible that in larger valleys pools are to be found at somewhat higher

altitudes, but in general it may be said that the moderately wet and wet forest area above 2,200 feet is without standing water except in the bromelias.

The habitats of reptiles and amphibians may be analyzed as follows:

Habitats below 2,200 feet:

Terrestrial

Ravine forest: Restricted to the lower part of the ravines; trees large, forming rather dense shade; ground litter well developed, but dryer than in the forest above 2,200 feet.

Scrub forest: On the ridges and in clumps on the plains; trees small, scraggly, giving little shade, interspersed with a spare growth of cacti, xerophytic herbs and shrubs; ground litter very little. (Pl. I, fig. 2; Pl. III, fig. 1.)

If the amphibians and riparian forms are excluded, there are few differences to be observed in the fauna of these two terrestrial habitats, probably because of the limited extent of the ravine forests. On the other hand, ground and arboreal species may be recognized.

Aquatic environments: Streams (shallow and larger lower down and swifter but with pools in the hills); ponds few in number and usually with much vegetation. The fauna is without aquatic species near the foothills, except possibly *Kinosternon integrum*, consisting of amphibians with aquatic larval stages and such riparian forms as the iguana and basilisk.

Habitats above 2,200 feet:

Terrestrial

Forest: Tropical rain forest, becoming gradually wetter from its lower limits; trees large, forming dense shade; a deep layer of forest litter. Cloud forest, in general like the rain forest, but cooler and more humid, large bromelias. (Pl. II; Pl. III, fig. 2; Pl. IV; Pl. V, fig. 2.) Fauna divisible into three groups—the arboreal, bromeliadicolous, and ground forms.

Artificial clearings

Aquatic environments: Streams small and torrential, without aquatic species of reptiles and amphibians. (Pl. V, fig. 1.)

It will be seen that seven associations of species of reptiles and amphibians are recognized: the ground species, arboreal species, and aquatic species below 2,200 feet; and the ground species, arboreal species, bromeliadicolous species, and artificial clearing species above 2,200 feet. It will also be noted that these associations may be grouped into two major habitats—the forest below 2,200 feet (in large part scrub forest and small ravine forests and open cactus areas, dry litter with higher temperatures and low humidity) grading through rain forest above 2,200 feet into a cloud forest (dense forest, deep wet litter, large bromelias, lower temperatures, abundant rainfall). The aquatic habitat below 2,200 feet furnished no strictly aquatic forms.

It is clear that the bromelias must be considered a minor habitat for the groups under consideration. The Bromeliaciae are in general an important habitat in the wet forest above 4,500 feet. (Pl. V, fig 2; Pl. VI.) The list of species found in these plants is as diversified as similar lists for other localities,[3] and includes earthworms, leaches, peripati, isopods, myriapods, cockroaches, spiders, Heteroptera, beetles, scorpions, insect larvae (flies, dragonflies, beetles), a salamander, and frogs of several species. However, lists of species taken in bromelias may be misleading, for all of the forms found in these plants are not, strictly speaking, bromeliadicolous. In bromelias are to be found species which are apparently confined to this habitat and those which are found here occasionally but quite as often, and in some cases much more commonly, in other situations affording concealment, such as under bark, in hollow trees, and in masses of vegetable debris lodged in trees and shrubs. It would seem to be best to restrict the term bromeliadicolous to those species which for the most part breed in the bromelias, and to those which, if not breeding there, occur principally in these plants. Under this definition one salamander, *Oedipus adspersus* (viviparous), and two frogs, *Eleutherodactylus cruentus* and *E. delicatus*, are bromeliadicolous forms in the Santa Marta Mountains, and *Eleutherodactylus sanctae-martae*, and *E. insignitus* may prove to be.

The distribution of the more common amphibians and reptiles found on the northwest slope of San Lorenzo is summarized in the following table. The cross-section made may be located by the towns and plantations given at the head of the chart. (Facing p. 40.)

It is to be understood that the data on the distribution of the snakes is fragmentary. This is to be expected, since collecting in this group is well known to be fortuitous in any region. The data is not without value, however, when it is considered that every species taken above 2,200 feet and not yet found on San Lorenzo below this altitude is known to occur on the lowlands in northern Colombia. This fact, with the further one that only one lizard and six frogs, a total of seven species out of forty-two common species (including the snakes), are not known from below 2,200 feet, shows clearly that the fauna has been in large part and probably entirely derived from the lowlands.[4]

A study of the table will reveal a certain amount of zonal arrangement of the species. Only five species, three amphibians, one lizard, and one snake out of nineteen desert forms have not been found above the desert, and of these at least the snake certainly occurs higher. Similarly, of a fauna of twenty-three species found in the dry forest, fourteen forms are known to occur on the desert, and of the nine forms not taken on the desert three are snakes and six are lizards, all of which will probably be found to occur there, as all but one have been found elsewhere on the lowlands. It is evident that the fauna of the dry forest and desert are prac-

[3] Compare Ohaus, *Ent. Zeitung, Stett.*, 1900, pp. 211-212, 237-240; Calvert, *Ent. News*, XXII, pp. 402-411; Scott, *Ann. and Mag. Nat. Hist.*, X, pp. 424-438.

[4] A similar condition was found by the writer in the San Francisco Mountains, New Mexico. *Bul. Amer. Mus. Nat. Hist.*, XXIII, 603.

tically the same, the ranges of but few of the species being affected at the common boundary of the more open plains and scrub forest.

There is a decided difference in the fauna roughly below and above 2,200 feet. Of a total fauna of twenty-three species in the dry forest, thirteen species do not occur above 2,200 feet, five others occur higher only in clearings, and still another is not known to breed above that altitude, so that nineteen out of the twenty-three species are naturally limited in upward range between 2,000 and 2,500 feet. The four species which range higher are snakes. It will be noted that seven of the lizards out of sixteen dry forest forms have not been found above 600 to 800 feet. These seven undoubtedly range higher and were not found between 800 and 2,200 feet because careful collecting could not be done in that region. The upper limit may be placed tentatively at 2,000 feet, because they have not been found at 2,200 feet, although some doubtless drop out well below this altitude. In brief, then, none of the amphibians of the desert and dry forest (six species) apparently breed above 2,200 feet; the only lizards of these habitats (16 species) ranging above this altitude are five which are found in artificial clearings, and it is the distribution of the snakes which seems to be little affected, four species out of six ranging higher.

None of the eight forms found in the moderately wet forest, between 2,200 and 4,500 feet, are peculiar to this area. A number of forms have not been found below it in this region, but these all range above it into the cloud forest. The cloud forest fauna consists of eighteen species, of which twelve have not been found below 4,000 to 4,500 feet. These are nine amphibians, one lizard, and two snakes. Moreover, of the eight forms which enter the moderately wet forest three forms (one amphibian and two snakes) do not range entirely through the area, one (an amphibian) reaches 2,200 feet, and four (snakes) are found in the dry forest. In other words, out of eleven forms of lizards and amphibians found in the cloud forest not one occurs below 2,200 feet, and the cloud forest and dry forest faunas are thus entirely different in respect to the lizards and amphibians and overlap only when the snakes are added.

As has been said, the moderately dry forest has no peculiar forms, but is composed of species which range below or above it, or in both directions. It is thus to be considered as an intermediate zone in the distribution of the reptiles and amphibians, and the fauna of the slopes falls into three groups, distinct as to species—a desert and dry forest group, twenty-four species; a cloud forest group, fourteen species; and a group of forms of general distribution, four species (of snakes). This vertical distribution corresponds to the vertical distribution of dominant terrestrial habitats.

Environmental Factors in the Vertical Distribution: It should be clearly understood by geographers that geographic data yield only indirect evidence of the environmental factors in distribution. It would be easy to attribute the apparent zonal distribution above described to temperature, to moisture, to the nature of the ground cover, or other factors, but this would be pure assumption. The writer has expressed the opinion[5] that no

[5] *The Geographical Review*, X, pp. 241-248.

one factor will account for the distribution of a fauna, and that zonal distribution of faunas based on temperature differences probably does not occur on mountains. It should be understood that this is not equivalent to saying that there can be no such thing as zonal distribution on mountains. Indeed, it may be accepted as a corollary of the proposition that the environment as a whole controls the distribution of each species, that when a large number of conditions are changed at about the same place a considerable part of the fauna may be affected. It has been shown that the dominant habitats change at 2,200 feet, and this means a change in many conditions of life. It is clear that zonal distribution occurs on San Lorenzo, and the data indicate that temperature is probably not the principal factor.

As stated, nine dry forest forms have not been found on the desert at Santa Marta. Of these, eight have been found in dry forests elsewhere on the plain. If there is a difference between the fauna of the desert and dry forest, the factors are not evident.

Of the lowland forms which do not get above 2,200 feet, five (lizards) go a little higher and three range from 100 to 2,300 feet higher in artificial clearings. This suggests that some other factors than temperature are, under natural conditions, effective at this point in limiting the upward range on San Lorenzo of the species of this group.

Of the cloud forest species in all groups (18), twelve are known to occur here or elsewhere in northern Colombia on the lowlands, which again suggests that on San Lorenzo the temperature of this area is not the only condition which limits the lower range of the species. It is to be noted that of the fourteen species known from the cloud forest and not lower than 2,200 feet, ten are amphibians which quite certainly do not lay the eggs in water, one being viviparous and nine more or less certainly known to lay eggs which produce young in the adult form, while three, possibly four, are associated with bromelias which do not descend lower. Furthermore, at least one lowland amphibian seems to be limited in its upward distribution by the absence of standing water above 2,200 feet, since it occurs well above that altitude apparently without breeding. In the cloud forest, the nature of the forest, the absence of standing water and the humidity are evidently factors with which to reckon.

The wet forest comes down to the coast on the north side of the mountains. Carriker (see p. 20) concludes from a study of the birds that the forest fauna on that side also comes down to sea-level, a conclusion that is substantiated by the occurrence at Don Diego of *Phrynonax poecilonotus* and *Phyllobates subpunctatus,* species not found below 2,200 feet on San Lorenzo. This lowering of the wet forest habitat is probably due in large part to a greater rainfall, and while the temperatures are also lower it is not possible that they are as low as in the cloud forest. The greater humidity and the forest are quite as likely to be critical conditons as is the temperature.

There is no reason to believe that the distribution of snakes is less effected by differences in temperature than that of lizards, and yet the data, while fragmentary, show less response on the part of the snakes to the

differences that exist between the dry forest and the cloud forest. The principal difference in habits between the two species in the groups in this region is in food habits, the lizards being largely insectivorous, the snakes mostly carnivorous. Certainly the food supply for lizards is much more different in the cloud forest and in the dry forest than it is for the snakes.

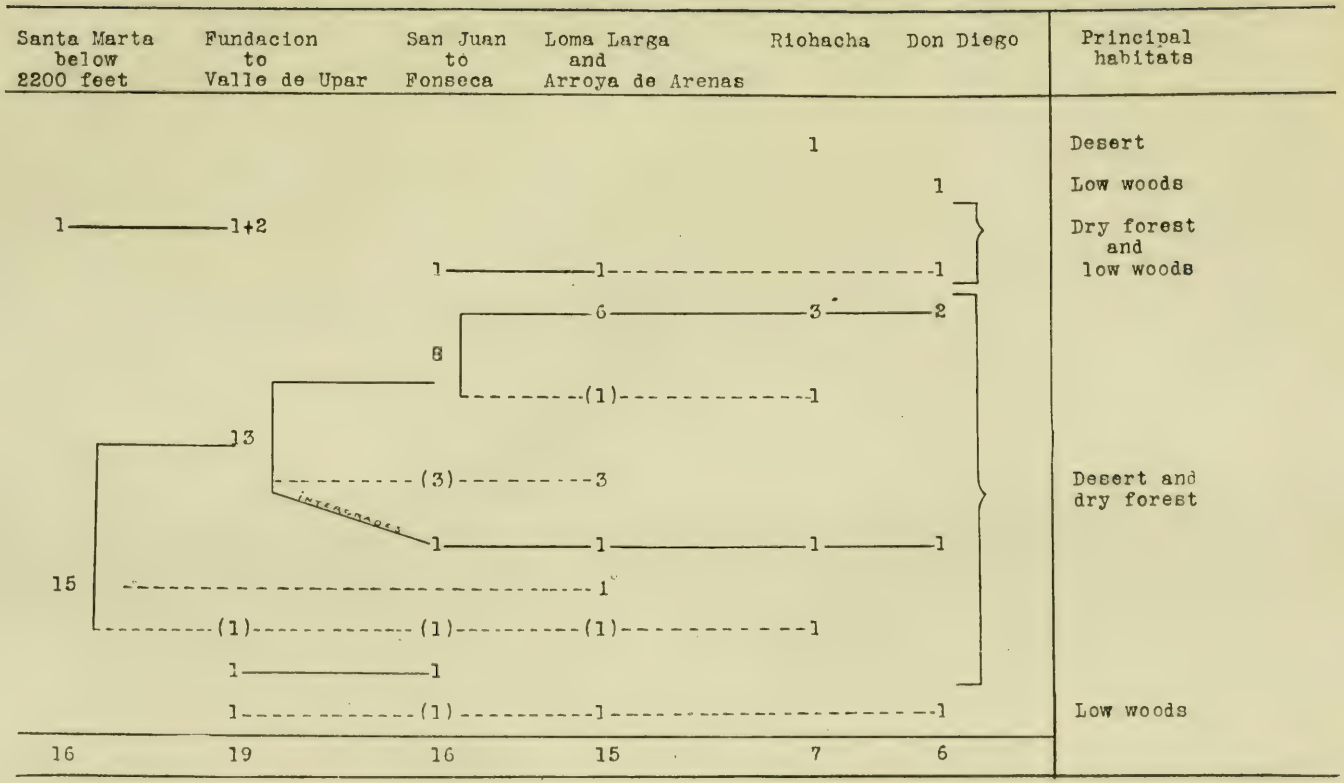
Taking into consideration the known altitudinal distribution and the habits of the species, the conclusion seems warranted that an absence of standing water and greater humidity and more shade above 2,200 feet[6] may be important factors in limiting the downward and upward migration, respectively, of the cloud forest and lowland amphibians, and that the more open conditions below 2,200 feet are more favorable than those in the wet forest for at least five of the lizards found below 2,200 feet, as they occur above this altitude when clearings are made.

It should not be inferred that the writer denies the influence of temperature in limiting the vertical distribution of particular species in this region. It is only meant that particular temperatures are not clearly responsible for the zonal distribution. It is quite possible that when several species are stopped at approximately the same place, in some cases a temperature difference may be the cause, while with others other factors may be operative. This view is quite in harmony with physiological data, and on San Lorenzo other factors are probably operative, since the abrupt change from desert to cloud forest is attended by changes in many environmental conditions for animals.

Relations of the Cloud Forest Faunas: The fact that, while the lizards and amphibians of the cloud forest are limited in their downward range in the moderately wet forest on the northwest slope of San Lorenzo, five out of the eleven species not found below 2,200 feet are known to occur elsewhere on the lowland, is more than evidence that temperature is not the only controlling factor in the vertical distribution, but would seem to indicate clearly that this fauna is or has been continuous with a lowland fauna containing many of the species found on San Lorenzo only above 2,200 feet. To obtain information on the origin of the cloud forest fauna, work was done at Don Diego and a trip was made entirely around the range from Riohacha to Fundación. In the work on the east and south sides of the range the lizards received principal attention, in the belief that being more easily collected they would be most likely to yield dependable results in the short time which could be devoted to the work. The distribution of the species is summarized in the accompanying chart.

From the chart it will be evident that a desert or dry forest extends from Santa Marta to Riohacha on the west, south, and east sides of the range, and that as far as the lizards are concerned it is the principal fauna of the lowlands. Of a total fauna of twenty-four forms only nine have not been taken at Santa Marta, where there is no heavy lowland forest. Of the nine forms not taken at Santa Marta four are distinctly forest species (*Mabuya agilis, Tupinambis nigropunctatus, Loxopholis rugiceps,* and *Polychrus spurrelli*), and it is believed to be significant that these species

[6] Conditions unfavorable for the development of eggs laid on the land.



Distribution of common lowland lizards in the Santa Marta region.

have only been taken at Don Diego, Aracatáca, Fundación, Valencia, Las Pavas, and Arroyo de Arenas.

As has been pointed out, the desert and dry forest is replaced by lowland forest in the valleys of the Aracatáca, Fundación, and Ariguaní, and by a dryer but still heavy forest in the valleys at Valle de Upar, San Juan de Cesár, and Fonseca, while at Loma Larga, Arroyo de Arenas, and Don Diego the forest is heavy. The occurrence of the four species named above at least indicates a wet forest element in the general fauna at the places mentioned, and since two of the cloud forest forms (*Phyllobates subpunctatus* and *Phrynonax poecilonotus*) have been taken at Don Diego, and since others (*Lepidoblepharis intermedius* and *Cryptobatrachus fuhrmanni*) have been taken in the Choco, it may be confidently expected that at least a part of the cloud forest fauna reaches the lowlands in the large valleys at the west end of the range and has been derived along this route from the lowland forest fauna of the Magdalena basin.

The large number of forms apparently peculiar to the cloud forest suggests that this almost completely isolated habitat possesses an endemic fauna. This can be determined only when much more is known about the reptile and amphibian fauna of Colombia.

The Distribution of the Desert and Dry Forest Fauna: It is well known to herpetologists that the faunas of Venezuela and western Colombia are different in many respects. The differences suggest a break in the distribution of a number of forms in eastern Colombia or western Venezuela. Too little is known of the distribution of most of the species to permit of the locating of the place or places where the change takes place for many species, but the distribution of the lowland forms in the Santa Marta Mountains region apparently throws some light on the problem.

The chart (p. 47) shows that on the south side of the range many of the lizards do not range beyond certain localities in a particular direction. It is evident that since the principal range of the species is not indicated and there are many chances that the distributions are not accurately known, this summary cannot be relied upon to reveal the eastern and western limits of all of the forms included. There are, however, several forms which here approach the range of near relatives or whose range is definitely enough known to indicate the nature of the relationships of the faunas of the two regions. Many forms are common to Venezuela and Colombia. Some eastern forms, e.g. *Hyla venulosa* (not included in the chart), occur as far west as Fundación, while one, *Tropidodactylus onca,* stops at Riohacha. *Ameiva bifrontata,* a Venezuelan form, is replaced between Fonseca and Valle de Upar by *Ameiva bifrontata divisus,* a Colombian form. One Colombian species, *Phyllobates subpunctatus* (not shown in the chart), does not get farther east than the Don Diego region, and is replaced by a nearly related form in Venezuela, while *Ameiva maculata* and *Cnemidophorus lemniscatus gaigei* enter western Venezuela at least before being replaced by other forms. These facts indicate that there is no sharp break between the faunas of Venezuela and Colombia, and that the eastern and western forms which enter the region are limited in range at different places.

LIST OF SPECIES

CAUDATA

Oedipus adspersus (Peters).—San Lorenzo, 4,500 to 7,000 feet; Rio Frio, 1,000 m. (U. S. National Museum); heights east of San Miguel, 6,000 to 7,000 feet (M. A. Carriker). Found principally in bromelias in the trees and on the ground; occasionally found in decaying logs and stumps or under decaying leaves.

This is a viviparous species, and both young and adults were taken in the bromelias.

SALIENTIA

Phyllobates subpunctatus (Cope).—San Lorenzo, 2,200 to 7,000 feet; heights west of San Miguel, 7,000 feet, and Don Diego (M. A. Carriker). A ground form generally found near water, and usually occurring in numbers where there are small clearings grown up to grass and herbaceous plants.

Although common, this species is a difficult one to collect and study in the Santa Marta Mountains. The breeding habits and tadpole have been described (Ruthven and Gaige, *Occ. Papers, Museum of Zoology, Univ. of Michigan,* No. 10). The eggs have not been found, but they are evidently laid on the land. Adult males carrying tadpoles have been found from June 4 to July 14.

Venezuelan specimens examined (La Gaira and San Esteban) are *P. trinitatus,* as stated by Barbour and Noble (*Bull. Mus. of Comp. Zool.,* LXIII, pp. 401-402). This species can be distinguished from *P. subpunctatus* by the fact that it either has a dark bar across the chest, or the throat, chest and belly are dark, but there are other distinctions between the forms. The only structural difference which the writer has found is in the roughness of the skin of the dorsal surface. Over most of the body the skin is smooth or slightly granular, but in the lumbar region it tends to be more granular, and in *P. trinitatus* is raised into more or less numerous and prominent warts. Of 20 specimens from Trinidad, 14 have distinct warts in the lumbar region, and in 6 Trinidad specimens and 3 Venezuelan specimens the warts are small and few in number. Of 18 Santa Marta specimens of *P. subpunctatus,* one has a few faint indications of warts, in others the skin is granular or smooth.

Notwithstanding a general similarity, the specimens from Trinidad and Venezuela (*P. trinitatus*) can be distinguished from those from Santa Marta (*P. subpunctatus*) by differences in the coloration. In the latter the black or blackish brown lateral stripe is very distinct and is usually bordered above by a light stripe which may extend around the snout, but at any rate is usually well defined forward to the eye. In Trinidad and Venezuelan specimens the dark line is less distinct and the light band is also much less distinct and often absent. In every specimen of *P. trinitatus,* except the very dark ones, the lateral dark band is widened or divided posteriorly to the eye, involving from a fourth to three-fourths of the tympanum and reaching the limb insertion. In *P. subpunctatus* the black band is a little widened on the neck and includes but the upper margin of the

tympanum. Specimens of *P. trinitatus* are frequently so dark that the dorsal coloration is obscured, but when this does not include the ventral surface the gular band is distinct. Both in *P. trinitatus* and *P. subpunctatus* the coloration of the sides consists of a variegated pattern of black or brown and light brown, dull yellow or white. In the former the dark colors predominate and the light colors have the form of light spots or dots and nearly always a short streak extending forward from the groin. In one specimen there is an angular light line below the black band in front of the arm. In *P. subpunctatus* the light color is more extensive and usually forms a reticulated pattern or conspicuous round spots, and the pale streak from the groin is seldom as definite as in Trinidad specimens and is usually absent.

Geobatrachus walkeri Ruthven.[7]—San Lorenzo, 5,000 to 9,300 feet. Taken under leaves on the ground in the forest and under stones and the stems of bromelias in the clearing at 8,300 feet. Very common in the latter habitat. (Pl. XI, fig. 2.)

The coloration is more variable than indicated in the original description. Most of the specimens are dark olive gray to olivaceous black above; the belly is gray in appearance due to the combination of a blackish wash and minute white dots. Some specimens have russet dots on the dorsal surface, and a few are brick red above, vinaceous rufus in the inguinal region, and Hay's russet on the belly. A narrow white or ochraceous tawny vertebral line may be present.

Atelopus ignescens (Cornalia).—San Lorenzo, from 5,000 to 7,000 feet. A forest form, the adults of which have not been found at a lower elevation than about 6,500 feet; young, recently hatched, were common in the quebrada Viernes Santo, from July 15 to July 24, at an altitude of about 5,000 feet.

The specimens agree closely with the descriptions, and if they are correctly referred to this form it is probable that the species will be found at lower levels in some of the large wooded valleys, such as that of the Ariguaní. The adults were taken on the ground in the forest, two of them in copulation on June 5. The smallest immature specimens were found at the margin of a stream, but there was evidently a later migration, for after the middle of July larger young were found several rods from the water. No eggs were found. The adults are very variable in color. The belly may be light orange yellow, apricot orange, pale ochraceous salmon, or dragons-blood red; the ground color of the back varies from olive to black.

Atelopus carrikeri Ruthven.[8]—Paramo de Macotama, 8,000 to 16,000 feet (snow-line). Taken along small streams, some of them rivulets from melting snow, by M. A. Carriker. Not known from other localities.

According to Mr. Carriker this amphibian has a very offensive odor.

Hypopachus pearsei Ruthven.[9]—Fundación. Found only under logs about an open marsh where they were rather common. (Pl. XI, fig. 3.)

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[7] *Occ. Papers, Mus. of Zool., University of Michigan,* No. 20.

[8] *Occasional Papers, Museum of Zool., Univ. of Mich.,* No. 28.

[9] *Proc. Biol. Soc. Wash.,* 1914, 77.

Gastrophryne ovale (Schneider).—Fundación. Only two specimens observed, both under logs in low woods.

Eleutherodactylus insignitus Ruthven.[10]—Heights east of San Miguel, 6,000 to 7,000 feet (M. A. Carriker). Taken in bromelias on the ground and in trees.

Eleutherodactylus cruentus (Peters).—San Lorenzo, 5,000 to 8,300 feet; heights east of San Miguel, 6,000 to 7,000 feet (M. A. Carriker). Mostly found in bromelias, either on the ground or in trees. (Pl. XII, figs. 4, 5.)

The habitat of this form is evidently the bromelias. In the forest at 5,000 feet on San Lorenzo it is to be found in numbers in the trees, the bromelias at this altitude being mostly above ten feet on the trees. From about 6,000 to 8,300 feet the bromelias grow lower down on the trees and on the ground in open places, but the frog is still confined to them. It is very abundant in the large bromelias which dominate the flora of the clearing at 8,300 feet.

The breeding habits have been described by Ruthven.[11] The eggs have not been found elsewhere than in bromelias. The breeding season is evidently long. Carriker collected eggs at San Miguel on April 24; and on San Lorenzo, in 1913 and 1920, many sets were found as early as June 9 and as late as July 25, the entire period during which the species was under observation. The observed dates of hatching are June 15, 19, 28, 30, July 1, 22-25. This indicates that the eggs are laid at different times during the rainy season. The number of eggs in a set is uncertain, for it has not been determined whether or not the females lay all of the eggs in one group. Often two or more sets may be deposited closely together, but whether by the same or by different females has not been determined. Usually from four to eight eggs are laid in one cluster, for when larger numbers are found in one group it is possible to distinguish more than one set. The adults are silent and retiring during the day, concealing themselves in the axils of the leaves; but at night they are active, the "song" being a rather harsh "check, check."

Eleutherodactylus carmelitae, new species[12]

(Pl. XI, fig. 1; Pl. XII, fig. 1.)

Diagnosis: To be distinguished from *E. sanctae-martae* Ruthven by the following characters: eye larger, tongue entire, tympanum less than one-half the orbital diameter, nostril equidistant from eye and end of snout; and from *E. megalops* Ruthven by greater size and larger eye, obovate tongue, larger disks (those of third finger larger than ear), smooth or finely granular texture of dorsal epidermis, narrower interorbital space (much narrower than upper eyelid), smaller palmar and sole tubercles, and in the position of the nostril.

Description: Tongue obovate, entire behind. Vomerine teeth in two short, transverse groups close together behind the choanae. Head as broad

[10] *Occ. Papers, Mus. of Zool., Univ. of Mich.*, No. 34.

[11] *Occ. Papers, Mus. of Zool., Univ. of Michigan*, No. 11.

[12] Named for Mrs. M. A. Carriker, to whom the members of the several expeditions are indebted for valuable assistance in the field work.

as long; snout rounded, with rounded canthus rostralis, longer than diameter of orbit; nostril equally distant from eye and end of snout. Interorbital space much narrower than upper eyelid; tympanum about one-fourth the diameter of orbit. Fingers free, first shorter than second; toes free; disks moderately developed, that of the third finger larger than the ear; metatarsal tubercles small. The hind limb being carried forward, the tibiotarsal articulation reaches between the eye and nostril. Skin smooth above and below, except that the region of the tympanum is granular; a glandular fold above the ear.

Green above, with black markings consisting of two spots on the snout, a cross band between the eyes, two streaks on the occiput, a W-shaped mark on the shoulders, followed by some short, irregular bands. Sides of head paler, with black bands radiating from the eye, one along the canthus rostralis, two downward and one along the auricular fold, the first three narrowly bordered with greenish white. Sides of body pale green with irregular markings. Chin and throat pale drab with small, white spots; lower surfaces elsewhere white, in some specimens bright yellowish-green in life.

Type specimen, total length 33 mm., hind-leg 59 mm., head 12 mm.

Type Specimen: Museum of Zoology, University of Michigan, Catalog No. 54,528; Quebrada Viernes Santo (5,000 feet), San Lorenzo, Santa Marta Mountains, Colombia; July 16, 1920; Alexander G. Ruthven, collector.

Habitat: Most often found under rocks in shallow streams, occasionally under leaves on the bank of streams, 5,000 to 8,200 feet, San Lorenzo.

Notes on Paratypes: The paratypes show little variation. In nine specimens the ear is from one-fourth to one-third the diameter of the eye and the heel reaches the anterior margin of the eye or the end of the snout when the hind limb is extended along the side. The ground color of all specimens is green, and the dorsal markings show a tendency to form longitudinal bands in some individuals.

Remarks: This species is apparently near *Eleutherodactylus surdus* Boulenger, from western Ecuador. As far as shown by the description of the latter, it differs in having an exposed, although somewhat indistinct, tympanum and a much narrower interorbital space.

Eleutherodactylus megalops Ruthven.[13]—San Lorenzo, 5,000 to 8,000 feet; heights east of San Miguel, 6,000 to 7,000 feet (M. A. Carriker). Only observed among leaves on the forest floor. On San Lorenzo very common from 5,000 to 7,500 feet; above 7,500 feet found in small numbers; not observed in the cleared area between 8,000 to 8,300 feet. It is possible that the species is debarred from the latter habitat by the more open conditions and that it reaches higher elevations in the heart of the range. (Pl. XII, fig. 3.)

During the day what was apparently the song of this species was heard constantly throughout June and July, but the eggs could not be discovered.

[13] *Occ. Papers, Museum of Zool., Univ. of Michigan,* No. 39.

With little doubt, the latter are laid under the forest litter and probably in the ground, the young hatching in the adult form. During the last few days in June tiny, evidently recently hatched, young were found in numbers in the forest. The material is very confusing, for the variations in coloration and in the glandular ridges are great, but the writer is now convinced that it represents but one species.

Eleutherodactylus sanctae-martae Ruthven.[14]—San Lorenzo, 4,500 to 9,300 feet; heights east of San Miguel, 6,000 to 7,000 feet, and heights east of Taquina, 8,000 to 9,000 feet (M. A. Carriker). Evidently a ground form, since 10 of the 25 specimens found were among leaves on the forest floor. One specimen taken at 5,000 feet was in a bromelia that had fallen to the ground, and four were in bromelias growing on the ground. Nothing has been learned of the breeding habits of the species.

Eleutherodactylus delicatus Ruthven.[15]—San Lorenzo, 4,500 to 8,000 feet. In 1913 three of these tiny frogs were found among leaves on the forest floor, and in 1920 two more adults were taken in bromelias. It is difficult to determine if the species is strictly a bromeliadicolous form, for it is so small as to be easily overlooked in tearing apart the plants. Eggs were discovered in the decaying leaves and litter at the base of the outside leaves of the bromelias growing on the ground at 8,000 feet, where they are easily overlooked. They are small, the membrane is tough and stained by the decaying vegetation, and the eggs are not united into masses or glued to the leaves. The young are born in the adult stage, and before hatching have a large, thin and transparent tail like that of *E. cruentus*. No recently laid eggs were found: six taken on June 21, 1920, hatched the same day.

In one adult the hind legs are not cross-barred. Another adult individual taken in 1920 differs from the original description in having a distinct tympanum, a longer hind leg (the heel reaching the nostril), in having a dark stripe from the end of the snout to the anus, and in possessing large, flat warts at the angle of the jaw. This specimen represents an extreme variation, for the recently hatched young are like this specimen, like the type, or intermediate in respect to the characters mentioned.

Ceratophrys calcarata Boulenger.—Fundación. Taken in the low forest and in the open country.

Several heads were found in forest pools, but living specimens were only seen at night. The species is much feared by the natives, evidently because they believe that the pugnacious habits indicate noxiousness. When disturbed the enormous mouth is opened widely and the frog snaps viciously at the disturber. Individuals experimented upon would seize a finger and allow themselves to be carried about for several minutes. The specimens agree closely with the original description, except that the tympanum may be distinct or indistinct.

Pleurodema brachyops (Cope).—Santa Marta; Aracatáca (Rehn and Hebard). Taken at night along irrigation ditches.

[14] *Occ. Papers, Museum of Zoology, University of Michigan*, No. 39.
[15] *Occ. Papers, Mus. of Zool., Univ. of Mich.*, No. 43.

Pleurodema pusilla (Ruthven)[16].—Santa Marta to Bolivar; Gaira; Fundación; Fonseca; Arroyo de Arenas. Found about ponds and marshes at the west end of the range and about pools in the low forest at Fundación, on the bank of the Rio Rancheria at Fonseca, and under rocks near pools in the bed of the Rio Barbacoa at Arroyo de Arenas.

Dr. Boulenger has (*in litt.*) referred the specimens described as *Paludicola pusilla* to Paludicola. It certainly does not belong to this genus as restricted by Méhely,[17] but is nearer to Pleurodema as defined by that author. The sternum has a long style terminated by a small, slightly cleft xiphisternum.

Leptodactylus typhonius (Daudin).—Fundación. Generally distributed, occurring in the clearings, about the open marshes, and in the low forest. During the day found under logs and fallen leaves, but active at night and easily taken in numbers by the aid of a headlight.

The specimens show two types of coloration, some having regularly arranged transverse spots, others a broad, pale vertebral stripe.

Leptodactylus pentadactylus (Laurenti).—Fundación; Valencia; Arroyo de Arenas; Don Diego (M. A. Carriker). Generally distributed at Fundación, being found under logs during the day and by headlighting at night. At Valencia observed both in the forest and on the savanna, in the latter habitat under logs. Taken at Arroyo de Arenas under stones at pools in the bed of the Rio Barbacoa, and at Don Diego in the forest.

The specimens have been identified by Dr. Boulenger.

Leptodactylus bolivianus Boulenger. —Santa Marta to Bolivar; Fundación; Valle de Upar; Don Diego. On the banks of streams and ditches. Specimens were found under logs and in dense grass during the day and by headlighting at night, the species being active at night.

The material has been compared with the type by Miss Joan Procter. It may be noted here that the writer cannot separate the Santa Marta specimens from paratypes of *Leptodactylus insularum* Barbour[18] from Saboga Island in the Bay of Panama.

Eupemphix pustulosus (Cope).—Santa Marta to 2,200 feet; Fundación; Valencia; Don Diego. On the desert at Santa Marta found about the ditches and marshes, and on the lower slope of San Lorenzo near streams in the wooded ravines. At Fundación found about the forest pools and under logs in the clearings and about the grass marshes. The Valencia specimens were taken in the flood-plain forest and under logs on the savanna. The Don Diego specimens were collected in the low forest. This species has the form of sternum described for *E. natteri* by Méhely.[19]

Bufo marinus (Linnæus).—Santa Marta to 4,500 feet; Gaira; Fundación; Loma Larga (observed). This species doubtless occurs in all localities about the mountains. On San Lorenzo it apparently does not breed above 2,200 feet, although it is not rare between 2,200 feet and 4,500 feet.

[16] *Occ. Papers, Mus. of Zool., Univ. of Michigan,* No. 30.
[17] *Ann. Hist. Nat. Musei. Hung.,* II, 1904, p. 213.
[18] *Bull. Mus. Comp. Zool.,* 1906, 46, p. 228.
[19] *Ann. Hist. Nat. Musei. Hung.,* II, 1904, p. 217, Pl. XVIII, fig. 9.

Bufo granulosus Spix.—Santa Marta to 2,200 feet on San Lorenzo; Gaira; Fundación; Aracatáca (Rehn and Hebard); Valencia; Valle de Upar. Found in damp places (about streams, ditches, ponds, etc.), on the desert and savanna, and in the flood-plain forest at Valle de Upar.

Hyla crepitans Wied.—Fundación; Aracatáca (Rehn and Hebard); Palomina and La Concepcion (W. W. Brown); Arroyo de Arenas. At Fundación headlighted about the open ponds and marshes, both on the ground and in bushes; at Arroyo de Arenas taken in the flood-plain forest. On August 8, 1913, the species was breeding in numbers in an open marsh at Fundación.

Hyla vilsoniana Cope.—A single specimen taken in a clearing at Fundación is referred to this species.

Hyla underwoodi Boulenger.—Aracatáca (Rehn and Hebard); Fundación. Headlighted in an open marsh at Fundación. Of four specimens from Fundación two are tan with four brown stripes and two are silvery with one gray stripe on each side.

Hyla venulosa (Laurenti).—A large adult taken in the forest at Fundación. The specimen is indistinguishable from specimens taken in British Guiana.

Cryptobatrachus fuhrmanni (Peracca).—San Lorenzo, 4,000 to 5,500 feet. Found along the streams in the quebradas, the adults among rocks and under leaves, the young clinging to rocks in the streams. (Pl. XII, fig. 2.)

In using the name *Cryptobatrachus fuhrmanni* the writer does not wish to give the impression that he is convinced Noble[20] is in error in referring the species to Peters' genus Hyloscirtus. At least to the satisfaction of the writer, however, Noble has clearly established neither its generic identity with *Hyloscirtus bogotensis* nor its family relationships. In 1913 Boulenger identified certain specimens from the Santa Marta Mountains as a new genus of the family Leptodactylidae, and the writer described these under the name of *Cryptobatrachus boulengeri.* Later, in 1920, suspecting that the specimens thus described were immature individuals and males of *fuhrmanni,* an effort was made to secure a series of specimens, and with this material at hand it is evident that only one form is to be recognized. The writer believes that Peracca was in error in referring the form to the genus Hyla. The fact that the sacral diapophyses are not dilated separates it from most of the forms in that genus. No characters are given in the description that makes it impossible to place it in the genus Hyloscirtus, but until a comparative study can be made of *Hyloscirtus bogotensis* and the form under discussion the writer prefers to consider Peters' species as one of doubtful generic affinities.

Noble places *fuhrmanni* in the family Leptodactylidae because it has "the cylindrical diapophyses of the leptodactylids," "the form of the sacral diapophyses is of more diagnostic value than the shape of the terminal

[20] *Bul. Amer. Mus. Nat. Hist.,* XXXVII, 803-807.

[21] *Occ. Papers, Mus. of Zool., Univ. of Michigan,* No. 33.

phalanges," and "claw-shaped phalanges are to be expected in the leptodactylids." In the opinion of the writer, these conclusions are not convincing.

Fry[22] has shown of the Leptodactylidae that "the Australian members of this family exhibit all stages between that of Heleioporus with considerably dilated diapophyses and the [cylindrical] condition shown in South American genera." It remains to be pointed out that not all of the neotropical leptodactylids have cylindrical diapophyses,[23] and that among the forms usually referred to the Hylidae there are considerable differences in the form of these processes, cylindrical, slightly dilated and expanded diapophyses being represented. It would thus seem to be clear that the form of the sacral dipophyses is not to be depended upon as a character distinguishing two families.

If the form of the sacral diapophyses is not a reliable family character, then the association of a particular shape with T-shaped or claw-shaped phalanges does not indicate the diagnostic value of the form of the terminal digital phalanx. The hypothesis that the claw-shape is derived from the T-shape, and that the former is to be expected among the leptodactylids, is interesting and will possibly be found to be true, but it must be admitted that at the present time the claw-shape prevails among the hylids with dilated diapophyses, and it is only found in the leptodactylids if such forms of doubtful affinities as *evansi, goeldi,* and *fuhrmanni* are placed in this family on the basis of that unreliable character the form of the sacral diapophyses. In view of the variations in the form of the sacral processes, it would seem either that the two families should be combined or that they should be separated on the basis of the form of the terminal digital phalanx, until more data is secured.

While it is uncertain whether one or more families are represented by the species now referred to the Hylidae and the Leptodactylidae, some progress may be made in the classification by revising the genera and segregating the species most alike in the totality of their characters. *Evansi, goeldi,* and *fuhrmanni* are alike in having claw-shaped digits, cylindrical diapophyses with somewhat dilated cartilaginous head, bell-shaped gills in the larval period,[24] and in that the female carries the eggs on the back and the young are born in the adult stage. It is proposed that these forms be united under the generic name of Cryptobatrachus until the identity of Peters' Hyloscirtus is established. The genus may be referred to the Hylidae until the value of the form of the terminal digital phalanx is fully understood. The writer is inclined to believe that the presence of cup-shaped gills in the larval stage indicates a close relationship between Gastrotheca, Cryptobatrachus, and Ceratohyla, whether or not it is believed that the

[22] *Proc. Roy. Soc. Queensland,* XXVII, p. 73.

[23] Noble has recently described a form with T-shaped phalanges and slightly dilated diapophyses (*Bul. Amer. Mus. Nat. Hist.,* XLII, pp. 441-443).

[24] Boulenger states that "no traces of gills are to be seen in the embryo of *H. goeldi,*" but in the description of *Hyla evansi* he states that the larva has "allantois-like membranous respiratory organs. In this respect it agrees with *Hyla goeldi* Blgr., to which it is nearly related, and with *Ceratohyla bubalus* Esp." *Proc. Zool. Soc. London,* X, p. 209.

three genera have diverged far enough to warrant their separation into different families.

Phyllomedusa tarsius (Cope).—Aracatáca; Fundación (observed). Dense woods in flood-plain forest. A single specimen is referred to this species, although it is not typical. The hind limbs are shorter than in the specimens of *P. tarsius* examined, the heel extending to the middle of the tympanum instead of to the anterior border of the orbit; the parotoids are indistinct, and the white markings around the vent, characteristic of *P. tarsius,* are lacking.

Hylella pearsei, new species[25]

Description: Tongue subcircular, slightly emarginate behind. Head broader than long; snout as long as diameter of orbit; loreal region high, oblique; interorbital space broader than upper eyelid; tympanum indistinct, about one-third the diameter of eye. Fingers webbed at base, first shorter than second; toes two-thirds webbed; disks of fingers and toes well developed, those of fingers larger than tympanum. The hind limb being carried forward, the tibio-tarsal articulation reaches the posterior margin of the eye. Skin smooth above; belly and an area below the thighs coarsely granular; a dermal fold from axilla to groin.

Above pale brown with numerous small, round, dark-brown spots, a poorly-defined brown band posterior to the eye, limbs without well-defined markings; ventral surfaces pale yellow.

Length, head and body, 14 mm.; length of head, 5.5 mm.; width of head, 6 mm.

Type Specimen: Museum of Zoology, University of Michigan, No. 54,639; Fundación, Santa Marta Mountains, Colombia; August 11, 1913; A. S. Pearse, collector.

Habitat: Taken in tall grass in an open marsh.

Remarks: Noble (*Bull. Amer. Mus. Nat. Hist.,* XLII, pp. 441-445) has recently placed one of the species hitherto referred to Hylella (*H. bucklevi* Boulenger) with the Leptodactylidae. *H. pearsei* has the claw-shaped terminal phalanges of the Hylids.

SAURIA

Gonatodes fuscus (Hallowell).—Santa Marta to about 800 feet on San Lorenzo; Fundación; Aracatáca (Rehn and Hebard); Las Pavas; Valencia; Valle de Upar; Fonseca; Riohacha. Very common in the desert scrub and dry forest and on walls in towns in the localities given above, apparently less common in the valley forests. Often found in logs, but generally on trees, particularly those which are partly decayed. Eggs laid in decaying wood.

Gonatodes vittatus (Lichtenstein).—Don Diego (M. A. Carriker); Palomina (W. W. Brown); Arroyo de Arenas; Fonseca. A very common species on and in logs and on trees in the forests at Arroyo de Arenas and Fonseca.

[25] Named for the collector of the type specimen, Dr. A. S. Pearse.

Phyllodactylus ventralis O'Shaughnessy.—Santa Marta to about 100 feet, San Lorenzo; Riohacha (observed). Only five specimens taken, of which two were in buildings in Santa Marta and Bolivar, one was found under a stone on the desert at Santa Marta (another was observed in a rock slide), and two were under the bark of standing trees in the dry forest above Bolivar. The one observed at Riohacha was in a house.

Thecadactylus rapicaudus (Houttuyn).—Bolivar to 600 feet, San Lorenzo; Las Pavas; Tucurinca (Rehn and Hebard); Arroyo de Arenas; Valencia; Fonseca. Found in the dry forest on San Lorenzo and in the valley forests in the other localities recorded. During the day only taken under the bark of trees; observed at night running about over the tree trunks.

Lepidoblepharis intermedius Boulenger.—San Lorenzo (5,000 feet). This species was described in 1915 as *Pseudogonatodes furvus*[26] just before the writer received Boulenger's description. The type of *P. furvus* Ruthven has been compared with Boulenger's material by Miss Joan Procter, and it is her opinion that they represent the same species. It should be noted that the Santa Marta Mountains specimen is much larger than the larger of the two specimens from the Choco.

Lathrogecko sanctae-martae Ruthven.[27]—Bolivar to 600 feet, San Lorenzo; Tucurinca (Rehn and Hebard); Fundación; Las Pavas; Valencia; Fonseca; Arroyo de Arenas. The very small size and secretive habits of this lizard make it easily overlooked. All but two specimens were found on the ground under leaves and logs. Two specimens were found in a decayed stump. During the hottest part of the day they are more active and can be seen darting about among the leaves.

Anolis solifer Ruthven.[28]—Known only from the type specimen, Catalog No. 6,549, Museum of Comparative Zoology, taken at La Concepcion by W. W. Brown.

Anolis gaigei Ruthven.[29]—San Lorenzo from Bolivar to 4,000 feet; Fundación; Tucurinca (Rehn and Hebard); Pueblo Viejo (M. A. Carriker); Pueblo Viejo and Palomina (W. W. Brown); Las Pavas; Valencia; Loma Larga; Arroyo de Arenas. Usually found on the ground or on grass or bushes.

While this anole has been found on San Lorenzo practically throughout the dry forest and up to 4,000 feet in the wet forest, it is apparently rather rare below 600 feet and above 2,700 feet, and above 3,000 feet is restricted to artificial clearings. It was found to be abundant from 2,000 feet to 2,700 feet. It was not a common form at Fundación, Las Pavas, Valencia, Loma Larga, and Arroyo de Arenas, but this observation means little in view of the short time spent at these places.

Anolis solitarius Ruthven.[30]—San Lorenzo, 4,500 to 6,000 feet; Pueblo

[26] *Occ. Papers, Mus. of Zool., Univ. of Michigan,* No. 19.
[27] *Occ. Papers, Museum of Zoology, Univ. of Michigan,* No. 21.
[28] *Occ. Papers, Museum of Zoology, Univ. of Michigan,* No. 32, pp. 4-5.
[29] *Occ. Papers, Mus. of Zool., Univ. of Michigan,* No. 32, pp. 6-8.
[30] *Occ. Papers, Mus. of Zool., Univ. of Michigan,* No. 32.

Viejo (M. A. Carriker); Palomina (W. W. Brown). This species is difficult to collect, as it frequents the heavy forest and is apparently not abundant. Only one specimen was taken as low as 4,500 feet on San Lorenzo; the others observed in this region were between 5,000 and 6,000 feet. In the forest on San Lorenzo about six were observed in two months' work, two on the ground, the others on ferns and vines to a height of 20 feet on trees. Most of the specimens taken were secured in the large quebrada of Viernes Santo, in 1920, where, owing to the width of the stream, the forest canopy is broken and there is a riparian association of low shrubs and trees. In this habitat the lizard was found on the small trees and shrubs.

Norops auratus (Daudin).—Santa Marta to 2,200 feet, San Lorenzo; Aracatáca (Rehn and Hebard); Fundación; Las Pavas; Valencia; Valle de Upar; Arroyo de Arenas; Palomina and Pueblo Viejo, 8,000 feet (W. W. Brown). Common in open woods and in clearings; generally found on grass and low bushes; abundant about the open marshes at Bolivar and Fundación.

Tropidodactylus onca (O'Shaughnessy).—This species was only found at Riohacha, and in but one place—a desert flat between the town and the Rio Rancheria. It was apparently not common. All of the specimens taken (17) were on the ground. It is very shy and at the slightest cause for alarm dashes into a hole.

It is to be noted that the adpressed hind limb does not reach the border of the eye, as stated by Boulenger, but the posterior border of the ear.

Polychrus spurrelli Boulenger.—Aracatáca (Rehn and Hebard). Taken from stomach of *Leptophis occidentalis*.

The specimen is referred to *P. spurrelli* with some doubt. It corresponds to the description of that form and differs from *P. marmoratus* in the scutellation of the body, but it is like the latter in having a gular denticulation.

Basiliscus barbouri Ruthven.—From Santa Marta to 2,200 feet; Gaira; Fundación; Valencia; Valle de Upar; Loma Larga; Palomina and La Concepcion (W. W. Brown). Apparently common in the localities in which it was found, occurring only along the streams, where it is generally found on rocks, logs, etc., near the water, occasionally in bushes up to a height of about twenty feet. When alarmed, individuals frequently dash across the water on their hind legs, and occasionally adopt this method of locomotion on land. (Pl. IX, fig. 1.)

Leiocephalus erythrogaster (Hallowell).—Bolivar to 2,000 feet; Tucurinca (Rehn and Hebard); Valencia. Only observed on the ground and on logs and rocks in dry forests.

The species is secretive and apparently somewhat local in distribution in the localities in which it was observed.

Iguana iguana (Linnæus).—Santa Marta to about 600 feet, San Lorenzo; Aracatáca (Rehn and Hebard); Fundación; Valle de Upar; San Juan de Cesár; Fonseca and Arroyo de Arenas (observed); Riohacha.

Where there are deep ponds or streams (*e. g.*, Fundación and Valle de

Upar) this lizard is generally abundant on the shores, frequenting the branches overhanging the water, from which they throw themselves when alarmed. In the regions where the streams are shallow the species is apparently less abundant, does not have this habit, and, while occurring along the streams, seems to be more generally distributed. At Riohacha old and young individuals were found in the desert scrub at a distance of a mile from water, in this habitat running about on the ground like the large Ameivas.

Tupinambis nigropunctatus Spix.—One specimen from Don Diego (M. A. Carriker). Reported by Mr. Carriker to be not uncommon in the cacao plantation at Don Diego. It does not seem to be recorded that this lizard is a scavenger. The natives on the Demerara River, British Guiana, capture them on fish-hooks baited with flesh.

Ameiva ameiva maculata (Fischer).—Santa Marta to Agua Dulce; Las Pavas (observed); Valencia; Valle de Upar; Fonseca; Loma Larga; Arroyo de Arenas; Riohacha. On San Lorenzo found on the desert and in dry woods to 2,200 feet, above 2,200 feet only in the clearings. In the other localities taken in the flood-plain forests.

This form is close to *Ameiva ameiva*, as stated by Barbour and Noble,[31] and the large series obtained shows that most of the scale characters given by these writers are not sufficient to distinguish the subspecies. The præanals are usually as much enlarged as in the typical form, and, while the shields on the under side of the tibia are usually a little smaller and more numerous in *maculata*, the range of variation in these scales is slight and overlapping in the two forms. The best scale character is the width of the occipital plate, which is quite constantly much less in *ameiva*, being usually less than one-half the greatest width of the adjacent scale in *ameiva* and with few exceptions from two-thirds to the entire width of the adjoining scale in *maculata*. Barbour and Noble state that *ameiva* has two pairs of frontoparietals, but this must be an error, since in a large series two pairs occur only as an abnormality, and this abnormality is also found in *maculata*.

Ameiva bifrontata divisus (Fischer).—Salamanca Coast and Santa Marta to 2,200 feet; Aracatáca and Tucurinca (Rehn and Hebard); Valle de Upar; Fundación. A common ground lizard in the localities mentioned.

The subspecies *A. b. divisus*[32] exists in the typical form from the coast at Santa Marta to Fundación. In a large series of specimens not one has the row of granules between the supraoculars and frontals continued anterior to the anterior border of the third supraocular. Of a series of eight specimens taken at Valle de Upar six are like the Santa Marta specimens and two have one granule anterior to the suture of the second and third supraocular. (See p. 62.) No representatives of the species were found between Fundación and Valle de Upar. It is possible that the Valle de Upar form will be found to be closer to typical *bifrontata* than to the subspecies *divisus* or intermediate, but this is not apparent from the material at hand. Also the writer is not certain of the identity of the Don Diego

[31] *Bul. Mus. Comp. Zool.*, LIV, p. 467.

[32] See Ruthven, *Occ. Papers, Mus. of Zool., Univ. of Michigan*, No. 2, 1913.

specimens. Of the two specimens in the collection from that locality, one is like *divisus* and the other is *bifrontata*. Since both types of scalation are found at Riohacha, the specimens are provisionally identified as *bifrontata*. For remarks on the relationship of the two forms see *infra*.

Ameiva bifrontata Cope.—Badillo; Fonseca, Arroyo de Arenas; Riohacha; Don Diego. Very common about Riohacha and the other localities given. A ground form found both in the woods and on the desert. One individual was seen to run on its hind legs.

At Riohacha about one-half the specimens taken (21 out of 50) have the first and second supraoculars entirely separated by granules. In 25 the granules between the frontal and supraoculars extend farther forward than the suture between the second and third supraoculars, and in four the granules end at that suture as in *divisus*. (See p. 62.) These differences are not sexual. Whether these specimens should be referred to *bifrontata*, as is done here, or are to be considered intermediate, can be determined only by the examination of a large amount of Venezuelan material to discover just how variable is *bifrontata*. From a very small series of the typical form from Venezuela the writer believes that it does not constantly have the first and second supraoculars separated. The status of the material from Don Diego, Arroyo de Arenas, Fonseca, and Badillo is not clear, but since one of two specimens from Don Diego and one of three specimens from Fonseca are typical *bifrontata*, while the two taken at Arroyo de Arenas, one from Fonseca and one from Badillo, have the inner row of granules continued farther than the suture of the second and third supraoculars, the logical conclusion is that the lizards in these localities are closer to *bifrontata* than *divisus*.

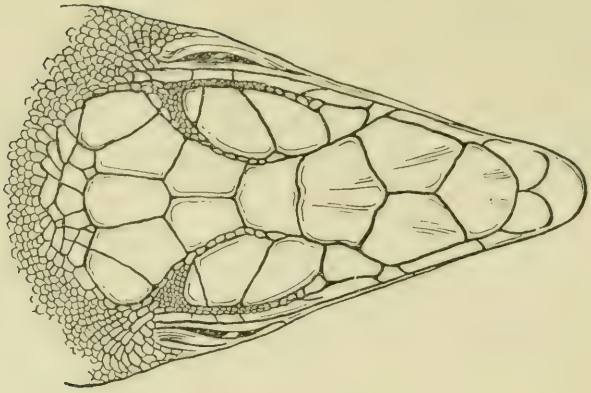
There can be little doubt that the two forms intergrade in the Santa Marta Mountains region, whether the lizards at the east end of the range are typical *bifrontata* or intermediate. The distribution of characters is shown in the following table.

Distribution of the characters of Ameiva bifrontata and Ameiva bifrontata divisus in the Santa Marta Mountains region.

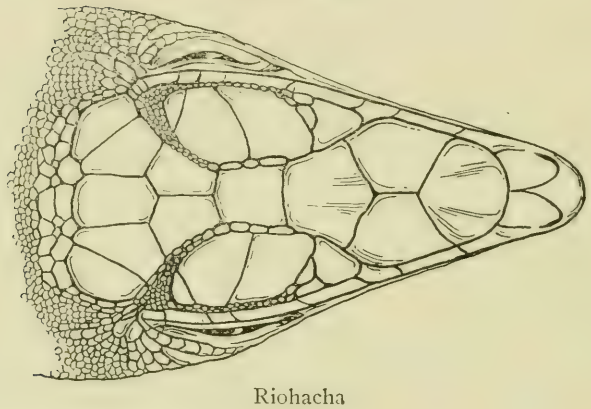
Superior granules, continued anteriorly:	*To suture of supraoculars 2 and 3*	*Beyond suture of supraoculars 2 and 3*	*Entirely around last 3 supraoculars*	*Subspecies*
Santa Marta	17	..	..	
Fundacion	9	..	..	*Ameiva b. divisus*
Valle de Upar	6	2	..	
Badillo	1	1	..	
Fonseca	1	1	1	
Arroyo de Arenas	..	2	..	*Ameiva bifrontata*
Riohacha	4	25	21	
Don Diego	..	1	1	

Cnemidophorus lemniscatus gaigei Ruthven.[33]—Salamanca Coast, Gaira (observed), and Santa Marta to 2,200 feet; Tucurinca and Aracatáca (Rehn and Hebard); Fundación; Las Pavas (observed); Valencia; Valle

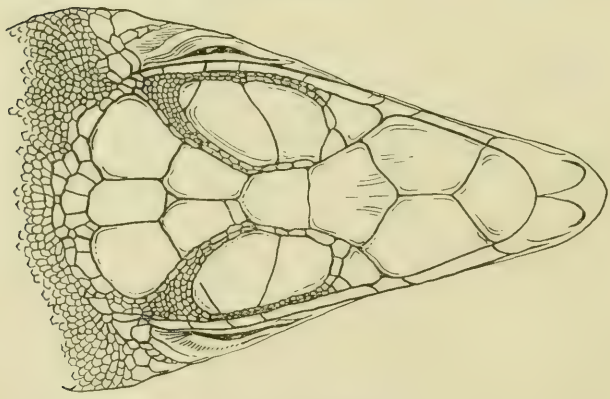
[33] *Occ. Papers, Mus. of Zool., Univ. of Mich.*, No. 16.



Santa Marta



Riohacha



Riohacha

Head scalation of Ameiva bifrontata, A. bifrontata divisus and intermediate specimens in the Santa Marta region.

de Upar; Badillo; Fonseca; Loma Larga; Arroyo de Arenas Riohacha; Palomina and La Concepcion (W. W. Brown); Don Diego (M. A. Carriker). Common on the lowlands all about the range, preferring open habitats, but not uncommon in the more open parts of the flood-plain forests at Valencia and Valle de Upar. Although a ground form, it readily climbs about in low bushes in search of food.

Leposoma dispar Peters.—Bolivar to 600 feet; Las Pavas; Tucurinca (Rehn and Hebard). Found among leaves in the dry forest, except that two specimens were in damp leaves in a marshy place on the bank of the Tamocal River.

Loxopholis rugiceps Cope.—Fundación; Las Pavas; Valencia. At Fundación found in some numbers under logs and in the grass about an open marsh and along the river; at Valencia two specimens found among leaves and under detached bark in the valley forest.

The males alone have pores, five on each thigh, and usually four, sometimes 5, in the præanal region. The chin shields are constantly one anterior and four pairs, the members of the first two pairs being in contact. The color of the males is richer (the dorsal parts blackish, the under surfaces more or less red), the females being brownish above and whitish below.

Tretioscincus bifasciatus (Dumeril).—Bolivar to 2,000 feet; Tucurinca (Rehn and Hebard); Fundación; Las Pavas; Valencia; Valle de Upar; Fonseca; Arroyo de Arenas; Don Diego. A common form both in the dry and valley forests. Found among fallen leaves, on and in logs, and on the trees.

In many specimens the color of the tail is a brilliant blue.

Bachia bicolor (Cope).—Bolivar to 600 feet; Tucurinca (Rehn and Hebard); Loma Larga; Palomina (W. W. Brown). Under logs and rocks in the dry forest.

There are two species of Bachia in the Santa Marta Mountains region, one of which is the same as *Heterodonium bicolor*. The specimens taken in the localities given above have the scales in 28 (29) annuli, and have from 44 to 46 scales between the occiput and the tail. The hind limbs are undivided and are decidedly larger than in the specimens which have been referred to the following form. There are four digital tubercles on the fore limbs in all specimens. It is possible that this species is synonymous with *B. flavescens,* but if so the definition of the latter must be changed, for the Santa Marta Mountains specimens have fewer scales than given by Boulenger for *flavescens,* and the dorsal scales are distinctly imbricate.

Bachia dorbignyi (Dumeril and Bibron).—Valencia; Valle de Upar; Fonseca. Found under logs in the dry forest at Fonseca and in dry parts of the flood-plain forests at Valle de Upar and Valencia. The species is a very active one.

The specimens referred to this species resemble those identified as *B. bicolor,* but differ in having the scales in 26 annuli, in having 46 to 48 scales from the occiput to the base of the tail, in having the hind limb more reduced, and in having but three digital tubercles on the fore limbs. It will

be noted that the scale counts are those of *B. tridactylus,* but it is clearly not that form, since the dorsal scales are overlapping and there is no interparietal plate.

Gymnophthalmus sumichrasti (Cope).—Bolivar to 600 feet; Tucurinca (Rehn and Hebard); Valencia; Badillo. The specimens, five in number, were taken on the ground under leaves, except that one of two specimens captured at Bolivar was found in the grass in a pasture. They are secretive and very difficult to capture, for they are mostly active only when the sun is shining, or at least are best seen then, and are usually observed slipping about among the leaves.

The scutellation does not conform to the description given by Boulenger[34] as shown by the following table:

Locality—Sex	*Longitudinal scale rows*	*Scale between head and tail*	*Scales at base of tail*	*Scales on posterior fourth of tail*
Bolivar, male	13	34	smooth	keeled
Bolivar, female . . .	15	38	keeled	
Valencia, male	13, 15	34	smooth	
Valencia, male	15	34	smooth	keeled
Badillo, female . . .	13, 15	38	smooth	

It will be seen that the numbers of scales on the median dorsal line are those of *G. quadrilineatus,* and that the number of longitudinal scale rows may be either 13 or 15 or intermediate. In the specimens with both 13 and 15 rows an extra row is added on the sides about half-way between the fore and hind limbs. In four specimens the scales on the base of the tail are smooth as given for *G. quadrilineatus,* but in one specimen they are distinctly keeled. In the two specimens in which the tail is intact the scales of the distal fourth of this appendage are keeled. The coloration is as described by Boulenger, except that the ventral scales may bear round, black spots.

Amphisbaena fuliginosa Linnæus.—A single specimen taken on San Lorenzo at an altitude of 4,000 feet, crawling along the ground in the forest at daybreak. A second individual was seen in the same locality.

Mabuya agilis (Raddi).—Don Diego; Arroyo de Arenas; Valencia; Las Pavas. Only found in regions of dense forest, but there taken in open as well as shaded places.

SERPENTES

Helminthophis petersii Boulenger.—Fundación; Valencia. Taken under logs in dry forest at Fundación and in the flood-plain forest at Valencia.

The two specimens secured have 22 rows of scales. Dr. Boulenger has advised me that he was in error in ascribing 20 rows of scales to the species, the type specimen having 22 rows.

Leptotyphlops macrolepis (Peters).—A single, slightly mutilated specimen found dead in the dry woods at Bolivar is referred to this species. It differs from the description given by Boulenger[35] in that the second labial reaches the eye, but it differs from *L. myopica* in the proportions and in

[34] *Catalog of Lizards, British Museum,* II, p. 428.
[35] *Catalogue of Snakes, British Museum,* I, p. 69.

having six lower labials. The diameter of the body is contained 41½ times in the length, the length of the tail 13 2/3 times.

Epicrates cenchria (Linnæus).—Fundación. A single specimen taken near Fundación was secured from a native.

Constrictor constrictor (Linnæus).—San Lorenzo, 2,200 feet. Taken in the forest. Reported as frequently seen at an elevation of about 2,200 feet and lower.

The characters given below are those of *C. constrictor,* not *C. imperator.* Dorsal scale rows 81, supraoculars 24, ventrals 247, subcaudals 55, rows of scales across forehead 18, dark cross-bands 20.

Drymobius boddaertii (Sentzen).—Two hundred feet above Bolivar (observed) to 5,500 feet, San Lorenzo; Valencia; Palomina and La Concepcion (W. W. Brown). A common ground snake in the wet forest on San Lorenzo; generally distributed above 2,200 feet, below this altitude only seen in ravines in the dry forest. At Valencia found in the flood-plain forest. The only food found in the stomachs examined was frogs. (Pl. VIII, fig. 2.)

Drymobius rhombifer (Günther).—San Lorenzo from 3,000 feet to 5,500 feet; Don Diego (M. A. Carriker); Palomina and La Concepcion (W. W. Brown). A common ground snake in the wet forest. One specimen was taken from an egg in the stomach of a *Lachesis lanceolatus.* The stomachs examined contained frogs, *Prostherapis subpunctatus,* and Eleutherodactylus sp. (Pl. X, fig. 2.)

The differences in the number of subcaudals is great, the extremes being 84 and 103.

Phrynonax poecilonotus (Günther).—San Lorenzo, 4,500 feet; Don Diego (M. W. Carriker). The specimen taken on San Lorenzo was in a coffee tree; the one from Don Diego was found on the ground in a dense cacao grove. The San Lorenzo specimen had eaten a partly fledged bird.

Peracca[36] has shown that the characters used to distinguish *P. poecilonotus, lunulatus, fasciatus,* and *guentheri* are not sufficient. The Santa Marta Mountains specimens are like those hitherto referred to *P. fasciatus* in that the dorsal scales are weakly keeled, the preocular is in contact or narrowly separated from the frontal, and the upper labials are eight. The dorsal scale formula is 21-19-17-15-13 and 21-23-21-19-17-15-13-(11). (Pl. IX, fig. 2.)

Drymarchon corias melanurus (Dumeril and Bibron).—San Lorenzo, 600 feet to 4,000 feet; La Concepcion, Palomina, and "Macotama or San Miguel, 6,000-8,000 feet" (W. W. Brown). On San Lorenzo found in the wet forest, and although but few specimens were seen, the number of cast skins would indicate that the species occurs in some numbers.

Chironius carinatus (Linnæus).[37]—Santa Marta; Palomina and La

[36] *Bol. Mus. Torino,* No. 253, pp. 6-8.

[37] Fitzinger *Syst. Rept.,* pp. 29 and 31, specifically designates Linne's *Coluber carinatus* as the type of his genus Chironius. Dr. Leonhard Stejneger (*in litt.*) has called my attention to the fact that *C. carinatus* has *Coluber chironius* Donndorf, *Zool. Beytr.,* vol. 3, p. 209, as a synonym and is consequently type by tautonymy.

Concepcion (W. W. Brown); Valle de Upar (observed). Of the two specimens seen one was in a river, the other on the bank of a stream.

Leptophis occidentalis (Günther).—One specimen from Aracatáca (Rehn and Hebard). In the stomach of this specimen was found the lizard referred to *Polychrus spurrelli*.

Leimadophis melanotus (Shaw).—Bolivar to 5,500 feet, San Lorenzo; Fundación; Arigaumí; Valencia; Arroyo de Arenas; San Miguel, 5,000 feet (M. A. Carriker). Taken on the edge of marshes and ditches at Bolivar, in the wet and dry forests in other localities on the lowland, in the forest at 5,500 feet, under the bark of a stump at Fundación (one), and on the savanna at San Miguel. One specimen had eaten a frog.

Leimadophis albiventris Jan.—Pueblo Viejo, 8,000 feet (W. W. Brown). A single specimen is referred to this species.

Lampropeltis micropholis Cope.—The writer has examined the specimen from Cacagualito, Colombia, recorded by Griffen[38] and examined and referred to this species by Dr. F. N. Blanchard.

Leptocalamus torquatus Günther.—A single specimen taken in a log in the dry forest at Valencia.

The specimen conforms to the description of the type in having a broad nuchal collar which was yellow in life. The head and the region just behind the collar are dark brown, the rest of the dorsal surface a brownish olive, the ventral surface pearly white. The portion of the rostral visible from above is about one-third of its distance from the frontal.

Atractus irridescens Peracca.—San Lorenzo, 4,000 to 6,500 feet; San Sebastian (W. W. Brown). Apparently not uncommon but a secretive form between 4,000 and 6,500 feet; usually found under logs and stones.

One specimen has 15 dorsal scale rows, and 9 have 17 rows. The upper labials are 7 in every specimen; the lower labials are 7 in 4 specimens, 7 and 8 in four, 8 in one, and 6-7 in one. The ventrals vary from 152 to 169, the subcaudals from 22 to 34. The coloration is very variable. The dorsal coloration in some specimens is brownish black with small transverse pale brown spots, in others dark brown with small, obscure black spots, and others (young) are red with prominent black spots and cross bars. A large specimen from San Sebastian is olive brown with black spots and cross bars. The ventral surface may be immaculate white or dull white irregularly spotted with black or with two broad black bands. The irridescence is strongly marked in the young and medium-sized specimens.

The writer is not sure of the identity of the specimens referred to, particularly of those from San Sebastian, but has given them this name as they conform to the descriptions of Peracca[39] and Boulenger.[40] The variations of the species in this genus have not been determined, and the characters used to distinguish the forms have evidently not been properly evaluated.

[38] *Mem. Carnegie Mus.*, VII, p. 176.
[39] *Bol. Mus. Torino*, No. 252, 1896.
[40] *Proc. Zool. Soc. London*, 1913, 1035.

Imantodes cenchoa (Linnæus).—A single specimen from Aracatáca (Rehn and Hebard).

Leptodeira albofusca (Lacépède).—Bolivar; Fundación; Fonseca. Found near irrigation ditch at Bolivar, about a marsh at Fundación, and in the flood-plain forest at Fonseca. A nocturnal species usually found under logs, under the scales of palms, etc., during the day. One specimen had eaten a frog.

In six specimens the dorsal scale formula is 19-21-19-17-15, and in three it is 21-19-17. For remarks on the relations of this form and *L. annulata* see *infra*.

Leptodeira annulata (Linnæus).—Arroyo de Arenas. A single specimen taken at night on a tree trunk in the flood-plain forest.

The dorsal scale row formula is 19-17-15. The ground color is brownish white with numerous broad, black-edged, brownish spots about one and one-half scales apart descending to the first row of scales.

After examining a series of specimens from South America, Griffen[41] has arrived at the conclusion that *L. annulata* is a synonym of *L. albofusca*. The writer does not concur in this opinion. It is true that many of the characters do not, because of overlapping, indicate two forms; but in the number of dorsal scale rows there is an apparent difference at least which is not brought out in Griffen's counts. When two species are as much alike as these two, the maximum number of scale rows means little. It is the average for the entire body that is significant. In *L. albofusca* the scales are usually 19-21-19-17-15 or 21-19-17 in the females and usually 19-17-15-(13) in the males. From the number of specimens of *L. annulata* recorded with 19 rows the usual formula is evidently 19-17-15. The two forms can be considered identical in the dorsal lepidosis only if it is revealed after a study of large series that the scale formulae are the same.

Clelia petola (Linnæus).—Don Diego (M. A. Carriker); La Concepcion (W. W. Brown). The specimen taken at Don Diego was on the ground in a cacao plantation.

In all of the specimens the dorsal coloration is principally red, the tip of each scale is tipped with black, and the black cross bars are present only on the anterior one-third of the body and distinct only on the anterior one-fourth.

Oxybelis acuminatus (Wied).—Bolivar to 800 feet, San Lorenzo; Fundación; Arroyo de Arenas; "Macotama or San Miguel, 6,000-8,000 feet" (W. W. Brown). Common in trees and bushes at Bolivar, and taken in the same habitat at Fundación and Arroyo de Arenas. Known locally as the bejuca snake. (Pl. X, fig. 1.)

The scale formula is 17-15-13, 15-17-15-13, and 15-17-15-13-11.

Erythrolamprus aesculapii (Linnæus).—San Lorenzo from 4,500 to 6,000 feet; Palomina, La Concepcion, Pueblo Viejo at 8,000 feet (W. W. Brown). A common ground form in the wet forest. A specimen taken on San Lorenzo had eaten two small individuals of *Atractus irridescens*.

[41] *Ann. Carnegie Mus.*, XI, pp. 321-326.

Another had eaten two frogs, *Eleutherodactylus cruentus* and *Geobatrachus walkeri*.

All of the specimens have black annuli in pairs, the number on the body varying from 11 to 14. The subcaudals are 44 to 64, the ventrals 186 to 200.

Tantilla longifrontale (Boulenger).—San Lorenzo, 4,000 feet; Palomina (W. W. Brown). The San Lorenzo specimen was taken on a rock in a stream.

Tantilla semicinctum (Dumeril and Bibron).—Valle de Upar; Bonda (a specimen in the Museum of Comparative Zoology, from the H. H. Smith collection). The Valle de Upar specimen was in dry woods.

Tantilla melanocephala (Linnæus).—Fundación; Valencia. Two specimens taken under logs, one in a swamp, and one in low forest.

Stenorhina degenhardtii (Berthold).—Valencia; Arroyo de Arenas. Only two specimens taken, both on the ground in dense woods.

The specimens have the color described as variety A by Boulenger,[42] and there is a broad, irregular black band on the median ventral line.

Micrurus mipartitus (Dumeril and Bibron).—San Lorenzo, 5,000 feet; San Sebastian (W. W. Brown). The single specimen found on San Lorenzo was among leaves in heavy forest.

The specimens (6) all have more than the maximum number of white rings given by Boulenger,[43] the number being from 69 to 75.

Micrurus dumerilii (Jan).—Macotama and La Concepcion (five specimens collected by W. W. Brown); Fundación (1). The Fundación specimen was found under a log on the margin of an open swamp.

The material is puzzling. The specimens correspond in many ways with the descriptions of Jan and Boulenger, and, as these writers had but one specimen each, it is to be expected that a series, such as is at hand from the Santa Marta region, will reveal variations. The only constant differences observed are in the size of the eye, which is three-fourths, not two-thirds, of its distance from the mouth, and in the relative length of the frontal and parietal scales, the former being shorter than the latter. The Fundación specimen is in coloration similar to those of Jan and Boulenger, and the larger one of Werner.[44] In the others the black bands are about half as wide as in those mentioned, the laterals are poorly defined and are often, and the middle ones occasionally, interrupted ventrally. This coloration is apparently represented by Werner's smaller specimen. In some specimens from La Concepcion the postnasal is broadly in contact with the preocular, in others the suture is short, and in still others these scales are completely separated. The triads on the body vary from 9 to 14, the ventrals are 180-200, and the subcaudals are 31 to 50.

It is the opinion of the writer that all of these specimens must for the

[42] *Catalogue of Snakes, British Museum*, III, p. 230.

[43] *Catalogue of Snakes, British Museum*, III, p. 431.

[44] *Abh. Konig. Bayerischen Akad.*, Bd. XXII, pp. 382-383.

present be referred to *M. dumerilii* (Jan), of which *M. colombianus* Griffen[45] is a synonym.

Micrurus hollandi (Griffen).—There is a single specimen in the collection of the Museum of Comparative Zoology, labelled "Santa Marta, Colombia, lowlands, Dr. Sellards," which corresponds closely with the description of *M. hollandi* Griffen (*loc. cit.*, pp. 218-219). The head is entirely black except for two yellow spots on the parietals.

Sibynomorphus mikani (Schlegel).—La Concepcion (W. W. Brown).

Bothrops lanceolatus (Lacépède).—La Tigrera (600 feet) to 5,000 feet, San Lorenzo; Fundación; Palomina (W. W. Brown). A nocturnal form said to be not uncommon up to 4,500 feet. Only one specimen observed as high as 5,000 feet on San Lorenzo. In the stomach of one specimen was found an egg of *Drymobius rhombifer*.

In all of the specimens the keels of the dorsal scales are nearly or quite as long as the scales.

Bothrops lansbergi (Schlegel).—Bolivar; Fonseca. Among leaves in dry forest at Bolivar, and under log in low woods at Fonseca.

The dorsal scale formula is 25-23-21-19, and in one specimen, a male, there are 25 rows only on the neck.

Crotalus terrificus (Laurenti).—San Sebastian (W. W. Brown); Bolivar (reported by M. A. Carriker).

The dorsal scale formula is 27-29-27-25-23-21-19.

CROCODILINI

Crocodilus acutus Cuvier.—One specimen on the ocean beach at Don Diego (M. A. Carriker); one seen on the bank of the Fundación River at Fundación.

Caiman sclerops (Schneider).—A single specimen taken in a stagnant lagoon in the low forest at Don Diego (M. A. Carriker).

TESTUDINATA

Testudo denticulata (Linnæus).—Santa Marta (reported) to 600 feet, San Lorenzo; Fundación; Copei. The species is much more widely distributed than indicated by the above list of localities. It apparently prefers dry forests and probably occurs in this habitat everywhere on the west, south, and east sides of the range. Shells were observed between Arroyo de Arenas, Fonseca, San Juan de Cesár, Valle de Upar, Valencia, and Las Pavas.

The species is assiduously hunted for food, and the shells are utilized as basins.

Kinosternon integrum (Le Conte).—A single specimen taken in an open marsh at Fundación.

[45] *Mem. Carnegie Museum*, VII, 216-217.

PLATE I

Figure 1. Harbor and city of Santa Marta as seen from the entrance to the bay.

Figure 2. Vegetation of the plains near Santa Marta. The vegetation of scraggly trees, cacti and other plants in some places tends to grow in clumps; in others it is more evenly distributed.

PLATE II

Figure 1. Wet forest at 4,500 feet on San Lorenzo.

Figure 2. Moderately wet forest below 4,500 feet on San Lorenzo. The abrupt transition to the dry forest at 2,200 feet may be seen at the low peak just to the left of the center of the picture.

COCKAYNE BOSTON

PLATE III

Figure 1. Dry forest, at 1,500 feet, on San Lorenzo. The trees have been largely removed and are replaced by an artificial dry savanna.

Figure 2. Detail of the moderately wet forest, at 4,000 feet, on San Lorenzo, showing the nature of the undergrowth.

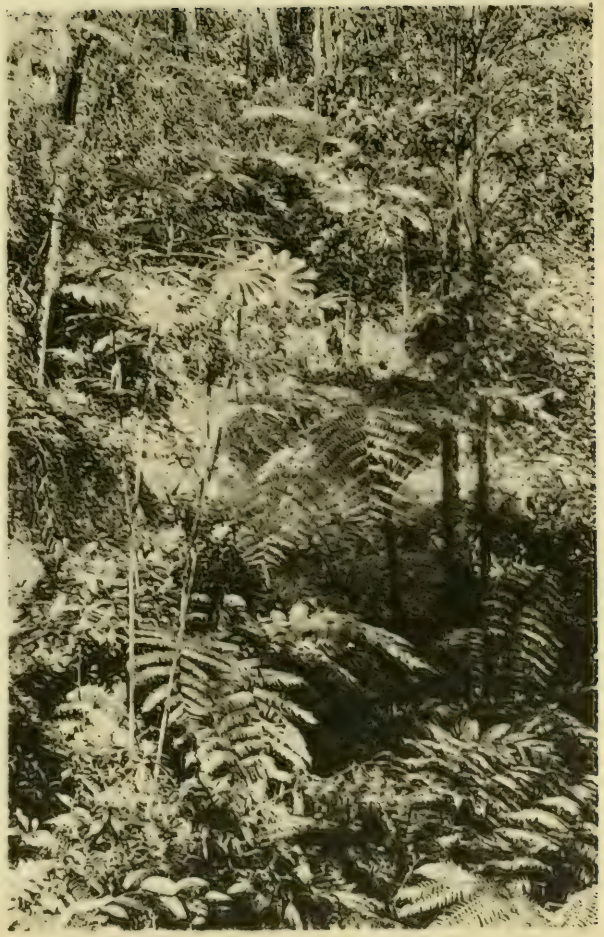


PLATE IV

The moderately wet forest, at 4,000 feet, on San Lorenzo, illustrating the size and nature of the trees. The wild fig is conspicuous in both pictures.

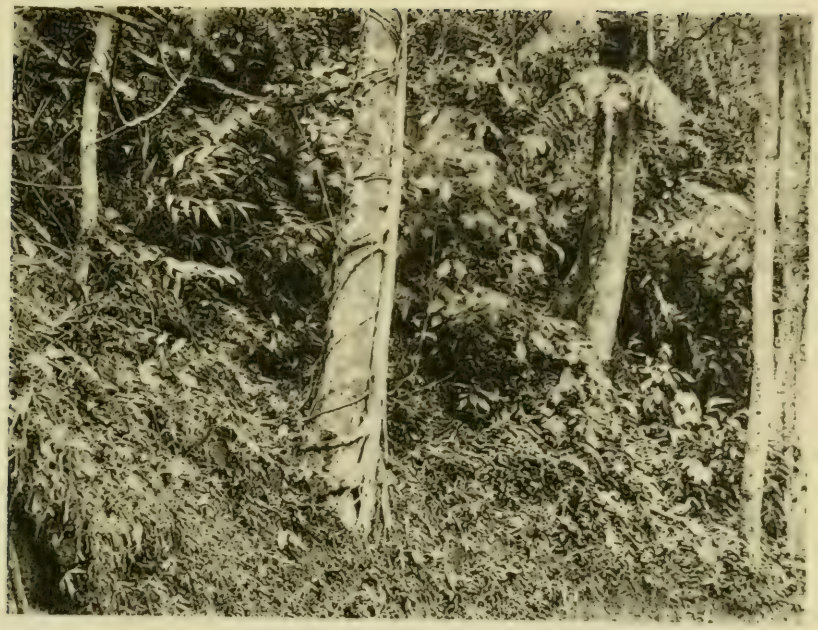


PLATE V

Figure. 1. A stream above 2,200 feet on San Lorenzo. The valleys are V-shaped, and the stream beds are very steep, so that the streams are torrential and characterized by many falls.

Figure 2. View in the lower part of the cloud forest on San Lorenzo, showing the abundance of bromelias on the trees.

PLATE VI

A burned area near the summit of San Lorenzo, the "Cerro Quemado." The dominant plant is a gigantic bromelia.

PLATE VII

Vegetation of the region about Riohacha. Over large areas the giant cacti and scraggly trees are mostly confined to mounds higher than the surrounding flats, but on the ridges and terraces with gravelly or stony soil, the dry forest is more evenly distributed. The river valley has an open forest of large trees.

PLATE VIII

Figure 1. Savanna at Valencia de Jesus. Between the clumps of trees and cacti the vegetation consists principally of grasses.

Figure 2. *Drymobius boddaertii* (Sentzen).

COCKAYNE BOSTON

PLATE IX

Figure 1. *Basiliscus barbouri* Ruthven; photographed in a stream on San Lorenzo.

Figure 2. *Phrynonax poecilonotus* (Günther), taken on San Lorenzo. This heavy-bodied snake climbs about in trees by using the tail as a prehensile organ.

PLATE X

Figure 1. *Oxybelis acuminata* (Wied), taken near Santa Marta. An arboreal species which has such a slender body that it can move directly through the branches of the trees at an astonishing speed.

Figure 2. *Drymobius rhombifer* (Günther). San Lorenzo.

PLATE XI

Figure 1. *Eleutherodactylus carmelitae,* new species, x1¾.

Figure 2. *Geobatrachus walkeri* Ruthven. About 2 1-5 times natural size.

Figure 3. *Hypopachus pearsei* Ruthven.

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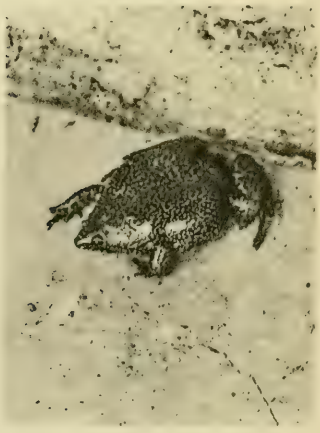

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SCHAYNE BOSTON

PLATE XII

Figure 1. *Eleutherodactylus carmelitae,* new species.

Figure 2. *Cryptobatrachus fuhrmanni* (Peracca). Female with eggs in position. San Lorenzo.

Figure 3. *Eleutherodactylus megalops* Ruthven. San Lorenzo. The large eyes are well shown in this picture.

Figures 4, 5. *Eleutherodactylus cruentus* (Peters). Adult and eggs. The eggs are in position on the leaf of a bromelia.

1

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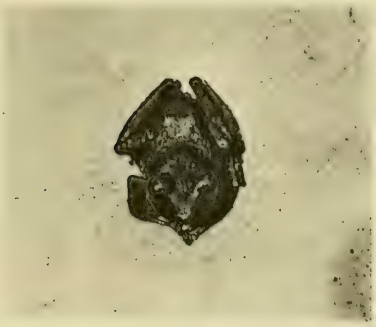

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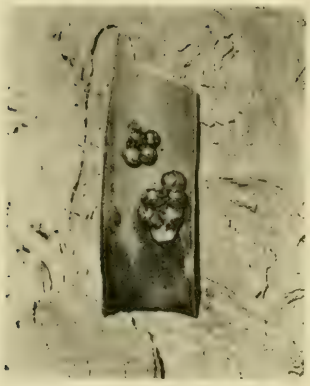

5

COCKAYNE BOSTON

CARIBBEAN SEA
Riohacha
GOAJIRA
Arroyo de Arenas
Santa Marta
Dibulla
Ciénaga Grande
Río Magdalena
Aracataca
Fundación
San Juan de Cesar
VENEZUELA
BOLIVAR
SOUTH AMERICA
SIERRA NEVADA DE SANTA MARTA
From a Survey by Mr F A A Simons
74°
73°
11°
10°

UNIVERSITY OF MICHIGAN
MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 9

Notes on American Species of Triacanthagyna and Gynacantha

BY

E. B. WILLIAMSON

ANN ARBOR, MICHIGAN
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The Miscellaneous Publications include papers on field and museum technique, monographic studies and other papers not within the scope of the Occasional Papers. The papers are published separately, and, as it is not intended that they shall be grouped into volumes, each number has a title page and table of contents.

Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

NOTES ON AMERICAN SPECIES OF TRIACANTHAGYNA AND GYNACANTHA (ODONATA)

By E. B. Williamson

During the past seventeen years many dragonflies from tropical America have been added to my collection. From time to time, as material in certain groups became of sufficient interest, reports on this material have been published by others as well as myself. In this paper it is proposed to study the specimens of the genera indicated in the title. During our field trips no effort has been spared to make our collections of these striking insects as complete as possible.

These various trips may be briefly summarized as follows. I collected in Guatemala and Honduras in 1905 and 1909. B. J. Rainey, my father, L. A. Williamson and I collected in British and Dutch Guiana and in Trinidad in 1912. In 1916-1917, Jesse H. Williamson and I, as members of the University of Michigan—Williamson Expedition to Colombia, collected in that country. In 1920, H. B. Baker, W. H. Ditzler, Jesse H. Williamson and I were the members of a collecting party for the Museum of Zoology, University of Michigan, in western Venezuela. The last three named devoted most of their time to collecting dragonflies, and Mr. Baker, who was more interested in other groups, brought in some specimens which are properly credited to him in each case. Jesse H. Williamson collected in Peru in 1920, and in Florida in 1921.

For all the assistance I have had, both from the members of the various parties and from the University of Michigan, I wish to express my deepest thanks. Mr. Rainey, Mr. Ditzler and Messrs L. A. and J. H. Williamson not only joined these expeditions at their own expense but gave all their time and strength in the field to collecting dragonflies, and their efforts and cooperation were the largest factor in the success and pleasure of these collecting trips.

The Venezuelan collection especially was so rich in aeshnines of the two genera Triacanthagyna and Gynacantha, embracing as it did no less than twelve species, that it was felt the material on hand from all the trips could be profitably reported on. This study was begun with the idea of making such a report but early difficulties in the determination of certain specimens compelled me to borrow material from other collections and to study carefully all the species in the New World.

Acknowledgements. Through Dr. Calvert I borrowed valuable material from the Philadelphia Academy of Natural Sciences (abbreviated as A. N. S. in the text), and from him, with the kind consent of Mr. Henshaw, I also obtained material belonging to the Museum of Comparative Zoology (abbreviated as M. C. Z. in the text) which Dr. Calvert had borrowed for study.

Dr. Calvert also turned over to me his notes and keys on American species of these genera, loaned me some otherwise unavailable literature, and has given me valuable advice and criticism. Through Mr. Herbert Campion I have been able to study one of the males in the British Museum, determined by Kirby as *G. subviridis*. Through Miss Bertha P. Currie, I have obtained the material of these two genera in the United States National Museum (abbreviated as U. S. N. M. in the text). Mr. W. T. Davis (abbreviated W. T. D. in the text) has kindly loaned me all his material in these genera. In the same way, Mr. Hugo Kahl of the Carnegie Museum (abbreviated Carn. Mus. in the text) has loaned me all the specimens of these genera in the collections at Pittsburgh. Through Dr. C. H. Kennedy I have obtained material belonging to the Ohio State University (abbreviated O. S. U. in the text). And Professor Needham has loaned me the specimens in the collections at Cornell. To Dr. Ris I am indebted not only for the loan of material without which this paper would be much more incomplete than it is, but he gave me permission to describe one species which he had already detected as new in his collection, and he also kindly loaned me some literature and has furnished me with various notes. Mons. Severin kindly sent me Martin's types of *G. satyrus,* and the specimens labelled *trifida* in de Sely's collection. These specimens are discussed in detail on pages 8-11. A review of the pages which follow will show how incomplete my study would have been without the unselfish cooperation of all these friends. Dr. Kennedy made all the drawings for this paper, and Miss Mina L. Winslow all the photographs of the wings.

The Genera Triacanthagyna and Gynacantha

I have not given the question whether the American species discussed in this paper should be included in one, two, or three genera any particular study and I have no well founded opinion in the matter. My knowledge of related species in other regions than the American is very limited, and, of the American species *aratrix,* for which Förster erected Selysiophlebia, I have seen no specimens. However, in the key to species which follows I have indicated at least some characters by which two groups, previously recognized by other authors, may be rather satisfactorily defined, and I am considering these groups as genera. As to the relationships of these two groups with old world groups, as I have stated, I have no opinion. In America I think two genera exist, regardless of their world relationships and the names by which they should be known. And Selysiophlebia remains to be studied. A factor that seems to me to have weight in this decision is the fact that in Triacanthagyna two groups have developed, somewhat paralleling groups in Gynacantha. In Triacanthagyna we have the paler *septima* with its unconstricted abdomen and the darker brighter *trifida* group with the male abdomens constricted. In Gynacantha, somewhat resembling the *septima* group of Triacanthagyna, we have several species of the *nervosa* group, while a number of darker and more brilliant species may represent the *trifida* group. At the same time it is not implied that Triacanthagyna has the wealth of specific adaptions which we find in Gynacantha. The two

genera may be recognized by the following characters: Upper piece of the arculus equal to or larger than the lower piece, Rs forked, separated from Rspl by at least three cells; Sc ending at the nodus; median space free; membranule of hind wings reduced, with only a slight extension on the anal margin; eyes in contact for a greater distance than the antero-posterior dimension of frons and vertex combined; males with the anal triangle and auricles well developed, and no dorsal teeth or well developed carinae on segment 10; females with two or three long inferior spines on 10.

Constricted and unconstricted abdomens.—These terms have been used rather loosely and indefinitely or relatively by authors. The third segment of the abdomen is the region involved. On the second and succeeding segments, except the last two or three, on each side of each tergite two distinct longitudinal carinae can be detected. One of these is the lateral carina and below this, on the margin, is the ventral carina. Both may be armed with small denticles. On the second segment of the male the ventral carina parallels the extreme margin of the genital fossa and often bears denticles of various forms. The lateral carina on the same segment in its anterior part is modified into the auricle. On the third segment the relative position of the lateral and ventral carinae can be accurately described and figured, and serves as a measure for the degree of constriction of the segment. If the carinae are widely separated and approximately parallel the segment is unconstricted. If the carinae fuse at about the level of the transverse carina and, anterior to that point, are joined or are parallel and in close juxtaposition the segment is constricted. If the carinae approach at the level of the transverse carina so they are separated by a distance possibly half the distance of separation near the apex of the segment, the segment may be defined as slightly or somewhat constricted. By defining this character in terms of the position of the carinae it is believed ambiguity or uncertainty in the future can be avoided, and especially in cases where the abdomen is not clearly constricted or not constricted.

T*he trifida group* (*Triacanthagyna*): This group of four species has given me the most difficulty in this study. All of them had been confused under one name *trifida,* and to add to the confusion *Triacanthagyna needhami* is a synonym of the true *trifida.* The females so far known, strange to say, are more easily recognized than the males. In the latter the appendages are so similar that in three of the species I detect no difference and in the fourth, *caribbea,* differences can be detected, probably, only by direct comparison with other species. Collections south of the equator will probably reveal additional species as practically all of the material seen by me is from more northern localities. Although the species are so similar I am nevertheless convinced, after many hours spent studying them, that the four are distinct.

The nervosa group (*Gynacantha*): In the same way in Gynacantha, the *nervosa* group offers some serious difficulties. In the *trifida* group no variation within a species in the form of the male abdominal appendages was detected. But among certain species of the *nervosa* group, especially *nervosa, bifida, croceipennis, litoralis* and *interioris,* the superior appendage seems somewhat flexible. Flattened out, there is a distinct angle on the inner

edge where the abrupt widening takes place. But if this angle warps or rolls up, as it seems to do frequently, then the angle is lost, and the passage from the basal stem of the appendage to the expanded apical portion is less abrupt. For example I have specimens of *nervosa,* which so far as I can detect, agree well with both of Ris' figures (35), figure 19 representing *G. bifida* and figure 20, *G. nervosa.* As in the *trifida* group body colors here are practically uniform in the various species, or, if differences exist, these are not well enough known to be of any service at this time. But fortunately in the males of the *nervosa* group, contrary to the condition found in the *trifida* group where all the males have constricted abdomens, constriction of the abdomen of the males has progressed in different degrees. And at the same time some striking wing patterns have been developed or have survived within the group, a thing which does not exist in the *trifida* group. By the use of these two characters, form of abdomen and color of wings, a fairly satisfactory classification of the material before me has been possible, but there are some individual cases which present problems I cannot positively solve at this time. See text under *G. litoralis.*

Eyes and flight: Dr. Calvert (9) has written an interesting account of the relative size of the eyes in various insects, especially in dragonflies, with reference to the varying amount of light in the different environments in which the insects spend their lives, and he points out the great relative advantage of the eyes of Gynacantha over some other species. In such predaceous insects as dragonflies keenness of sight and power of flight might be expected to vary directly. In Gynacantha, for example, it is probable that the increased size and efficiency of the eyes, make possible the swift and often erratic flight, which would otherwise often terminate fatally. In dark forests many genera of agrionines with eyes relatively very small, compared with Gynacantha, live in great numbers, apparently living in such environments more successfully even than Gynacantha. Their eyes are amply keen enough to detect food and mates, and to avoid the pitfalls spun by designing spiders. In fact, were they gifted with all of the powers of sight and flight of Gynacantha, and at the same time remained as small as they are, it is possible they might not survive in the environment where they now flourish. For Gynacantha escapes the ever present danger of spider webs not by keenness of sight but by sheer bulk and momentum. It is unusual to find a fully adult Gynacantha with no bits of spider webs attached to wings or body, strands which would have proved the undoing of a Heteragrion or a Palaemnema with equally unguarded flight. In fact Gynacanthas hawking in the evening may often be observed colliding violently with grass or sedge stems and leaves, and once a *nervosa* struck a motionless insect net handle with a resounding whack. Crepuscular flight is probably only an adaptation to the food supply and many aeshnines often practice it, though it seems more confirmed in certain species of Gynacantha and Triacanthagyna than in other genera such as Coryphaeschna and Aeshna. In Aeshna I have seen certain sun-loving species hawking late in the evening when it was so dark they were visible only against the sky or against the reflection of the sky in the pool over which they were flying. At this time their flight was as

swift and as well controlled, apparently, as is possible for the larger eyed Gynacantha. Generalizations on the habits of flight of aeshnines are dangerous even when a large amount of data is available, but it may be mentioned that the equally large-eyed Neuraeschnas, on the single occasion I observed them, were crepuscular with swift and well controlled flight. I believe such crepuscular flight as is found in Gynacantha and Triacanthagyna and possibly other aeshnine genera is a specialized habit related to the food supply, some approach, under favorable conditions, to which is seen in Coryphaeschna, Aeshna, Boyeria, and probably other aeshnines, Tholymis and Pantala among the libellulines, and Neurocordulia among the cordulines. Certainly it is an adaptation found chiefly among the aeshnines and possibly not present at all in the Zygoptera, though certain species are noticeably most active late in the afternoon.

Ecological notes: That there is some sensitive adjustment to their environment is indicated by the spotted distribution of even the most widely ranging species of Gynacantha. For example, Palma Sola, Venezuela, is in a very level heavily forested region and lies about 35 meters above sea level. By railroad it is about 37 kilometers from Tucacas on the coast. Here in the evenings *nervosa* flew literally by hundreds or thousands. About 30 kilometers farther inland on the railroad lies the plantation Boqueron, at an elevation of about 125 meters. In the vicinity are many beautiful streams of different sizes and character. There are extensive pastures and cornfields but closely surrounding these are forests as dense and of the same general character as the forests about Palma Sola. The landscape is varied with some low hills and the general result is a region apparently much richer and certainly much more attractive than the region about Palma Sola, but during eight evenings at Boqueron we saw not a single *nervosa* though we looked diligently for them. Cristalina lies far inland in Colombia, near Puerto Berrio, which river port is about 164 leagues above Barranquilla. The elevation of Cristalina is about 320 meters. In general the topography roughly suggests the topography about Boqueron, though there is less flat forest. In fact it differs from Boqueron about as Boqueron differs from Palma Sola. But at Cristalina we found *nervosa* flying in about the same numbers as we found them at Palma Sola. Why were they absent at Boqueron? There is also the factor of seasonal distribution to consider. We may expect this to become more evident as one leaves the equator. It was conspicuously evident at 15-16°N. at sea level at Puerto Barrios, Guatemala, where *T. septima* was abundant in May and June and entirely wanting, that is, there were no great crepuscular flights, in January and February, when none was seen. Generalizations as to where and when these aeshnines may be found are therefore dangerous. They are essentially forest insects, though the forest may be low and chaparral-like; they require moist earth for ovipositing, and rains or overflow must provide water for the larvae; species and individuals seem most numerous at comparatively low elevations above sea level; and they are essentially tropical.

Organization of Results

This paper originated in my efforts to identify properly specimens in my own collection and its purpose is to facilitate identifications by other students. It makes no attempt to summarize completely the extensive literature on these species and it should therefore be regarded as supplemental to the other literature. To make it as useful as possible for the purpose for which it has been prepared different parts of the paper are designed as a check on other parts. For example, in the keys to species the least possible use has been made of venational characters and of male appendages. The tabulation of the venational characters and the figures of appendages therefore will serve as checks on determinations made by the key. In the text under each species are given data on size, form and size of female appendages where known, and in some cases additional data designed to facilitate identification of material, and notes on habits, colors in life, etc. As a check on my own determinations I have listed all the material studied by myself, but I have not summarized all the records gathered by others, since as stated above this paper is merely supplemental to the other literature.

The abbreviations used in designating various collections have been mentioned above in the paragraph under acknowledgments; E. B. W. refers to my own collection. Dr. Walker's use of certain letters in designating abdominal spots, as explained by him (see under his name in the bibliography) has been frequently used in this paper. All measurements are in millimeters, and the length of the abdomen as given is in every case exclusive of the appendages. Notes on colors of living specimens must not necessarily be considered complete. For example, failure in any case to mention pseudopupillae must not be taken as evidence that these are lacking. Field notes are often made under unfavorable circumstances, and I have often found myself regretting the lack of detail or lack of definiteness which the notes sometimes show. In some cases I have slightly re-edited these notes but in no case has anything been added to them.

In the field only a small hand lens was available for examining material. Later studies have been made with a Zeiss binocular, using the number 2 eyepiece and the F 55 and A_2 objectives.

Specimens in the de Selys Collection, Following Martin's Revision, under the Labels Triacanthagyna trifida and Gynacantha satyrus

Several months after this paper had been completed and sent to Dr. Ruthven for publication Mons. Severin kindly sent me for study the thirty-two specimens in de Selys collection under the label *T. trifida* and the six male types (not seven, as stated by Martin) of *G. satyrus*. Six species are included in this lot of thirty-eight specimens. In order to avoid as much as possible the rewriting of several parts of my manuscript, already long since completed, these specimens are considered one by one in this section of my paper, and only the changes rendered imperative in the text are made. These changes have to do with *Triacanthagyna* (*Gynacantha*) *satyrus* Martin.

The study of this material, sent me by Mons. Severin, tends to confirm my opinion expressed under *T. septima* in the text, that *septima* is really a synonym of *obscuripennis*. Incidentally, the matter I could not understand, *i. e.* why de Selys' collection contained only a single male of this widely distributed and common species, is explained; there are seven specimens under the labels *trifida* and *satyrus*.

The study of this material also causes me to think I have included two species under *T. ditzleri,* but at this time adequate characters for separating the two are not discernible. The small specimens from Central America and northern South America will probably be found to be specifically distinct from the similar but larger specimens from southern Brazil. One of these males is referred to in the text under *T. ditzleri.* Other specimens are present in de Selys' collection under the label *trifida.* I have designated as the type of *ditzleri* a male of the smaller northern and better known form. A solution of the problem of the status of the two forms awaits adequate material from southern Brazil.

An examination of the following report on these thirty-eight specimens will impress the student, I think, with at least two things. It shows again, what should now be well known, that differentiation among species in at least certain aeshnine genera has progressed along such lines that specific characters are not conspicuous or obvious to the student, however effective they may be in nature. Following from this, the greatest care and discrimination in the determination of species is necessary. Incidentally it may be remarked, the description of new species in such groups, based on a single female or on any other number of specimens which the particular case renders inadequate, is not science but is an affliction.

Thirty-two specimens in de Selys' Collection labelled Triacanthagyna trifida

Unless otherwise mentioned, in addition to labels indicated, each specimen bears the following label: Collection Selys. Triacanthagyna trifida Rb. Revision Martin, 1909. Triacanthagyna trifida Rb.

1. male | Honduras | *Gynacantha trifida?* R. male (in de Selys' hand) | C'est espece different Förster (and on the reverse) il n'est pas trifida (all in Förster's (?) hand)|. The specimen is *T. septima.*

2. male.|Cr. 2.|7|. The specimen is *T. septima.*

3. female.|Mexique Salle|28|. The specimen is *T. septima.*

4. female.|female 151|Boctes (?)|6|. The specimen is *T. septima.*

5. female.|151 female |14|16|. The specimen is *T. septima.*

6. female.|Para, Schulz (?) (in de Selys hand).|10|. The specimen is *T. septima.*

7. male.|Copa Cabana|113|32|. By its hamules it is *T. ditzleri.* In the anal loop three cells in the anterior row in both hind wings. This is the larger Brazilian form provisionally referred to *ditzleri* in this paper.

8. female.|Botafogo|14|. This is probably the female of the larger Brazilian form referred to *T. ditzleri.* In the anal loop there are two cells in the anterior row in both hind wings.

9. female.|Botafogo|21|. Same remarks as under number 8.

10. male.|Bocas (?) Sta. Cather. (?)|8|. Same remarks as under Number 7, except that the anal loop in one wing has three cells in the anterior row while the other wing has two.

11. male.|Bates|143 A|143 var. A minor|11|. The specimen is typical *T. ditzleri.*

12. female.|Bates|38|12|Gynacantha praedatrix Bates. Amazones (in de Selys hand). The specimen is typical *T. ditzleri.*

13. male.|Panama (in de Selys' hand)|9|. The specimen is typical *T. ditzleri.*

14. female.|Coary. Amaz. Sup. (in de Selys' hand)|17|. The specimen is typical *T. ditzleri.*

15. male.|Bates|51|30|. The specimen is typical *T. ditzleri.* There are three cells in the anterior row of cells in the anal loop in the right hind wing.

16. female.|Dusem (?) 15/2 (in de Selys' hand)|24|. The specimen most closely resembles *T. ditzleri,* but has the anal loops unusually large with three cells in the anterior row of cells. I believe it is *ditzleri* but identification is not positive. Venation shows it is certainly not *trifida.* In size and degree of constriction of the abdomen it is *ditzleri.*

17. male.|Small rectangle of silver paper|Sta. Cruz, Bolivia|3|. Hamules concealed by glue or shellac; eyes are gone and the specimen is badly faded, but the legs and appendages are those of *T. caribbea,* to which species, in the absence of more and better material, this single specimen is referred.

18. male.|25 (?)|Para St.|4|. Head and superior appendages gone, but the legs and hamules clearly show it to be *T. caribbea.*

19. male.|Para. Schulz|23|trifida. petite sous race (Förster's (?) hand)|. This is a specimen of *T. satyrus* and doubtless belonged to the same lot of specimens as that from which three of the types of *Gynacantha satyrus* were selected.

20. male.|C1.|13|. This specimen, which lacks the last seven abdominal segments, is *Gynacantha adela.*

21. female.|Bocas (?) Sta. Cath.|a small rectangle of orange colored paper|14|. The specimen lacks all its legs but one and the apices of the appendages are gone. I think it is certainly *Gynacantha adela,* certainly it is not a Triacanthagyna.

22. male.|male.|a small rectangle of gilt paper|Cuba|5|trifida Ramb.|A. trifida|Type Gynacantha trifida Rb.| Stock label, described in introductory sentence, with the additional word *type.* The eyes are gone, the abdomen is slightly damaged, and the left superior appendage is gone. This is one of Rambur's types of *trifida.*

23. female. Similar to Number 22, and also labelled *type.* The eyes are gone and all of the abdomen but a few fragments of two or three basal segments.

24. male. Similar to Number 22, also labelled *type,* and carrying in addition the following label in de Selys' hand; Triacanthagyna trifida R. Type de Rambur, Coll. Serville, male, Cuba. The eyes are gone and only the two basal abdominal segments, themselves damaged, remain.

25. male.|Cuba|22|. The specimen is *T. trifida.*

26. male.|Cuba|25|Triacanthagyna trifida. Rb. Collection Selys|. Lacks the stock label described in the introductory sentence. The specimen is *T. trifida.*

27. male.|Cuba|20|————(?) trifida (and on the reverse) Förster dixit|. The specimen is *T. trifida.*

28. male.|Cuba|18|. The specimen is *T. trifida.*

29. male.|S. Domingo|29|Triacanthagyna trifida Rb. Collection Selys|. Lacks the stock label described in the introductory sentence. The specimen is *T. trifida.* This and numbers 30 and 31 doubtless belonged to the same lot as one of the specimens selected as one of the types of *Gynacantha satyrus.*

30. male.|Santa Domingo|26|113|Triacanthagyna trifida R. St. Dominque male (in de Selys' hand)|. The specimen is *T. trifida.*

31. male.|S. Domingo|31|Triacanthagyna trifida collection Selys|Triacanthagyna trifida Rb.|. The specimen is *T. trifida.*

32. female.|Jamaique Deby|15|Triacanthagyna trifida R. female Jamaique (in de Selys' hand)|. The last seven abdominal segments are gone. In size, venation, and constriction of abdomen, the specimen is *T. trifida.*

The six (not seven as stated by Martin) types of Gynacantha satyrus in de Selys' Collection

These all belong to the genus Triacanthagyna. Each specimen bears the two following labels in addition to labels indicated in each case: Collection Selys Type. Gynacantha satyrus M. Révision Martin 1909. Gynacantha satyrus Mart.; and a red bordered label on which is printed TYPE, and on which is written Gynacantha satyrus Mart.

1. male.|Pilanqui (?) Ecuador (?)|2|. The specimen is *T. septima.*

2. male.|S. Domingo|6|. The specimen is *T. trifida* and is probably one of the same lot as number 29, 30 and 31 above, properly labelled *T. trifida.*

3. male.|Yurimaguas, Perou|56|1|. The specimen is *T. satyrus.*

4. male.|Para. Schulz|3|. The specimen is *T. satyrus.* Numbers 4, 5, and 6 of this lot and number 19 above doubtless belonged to the same lot of specimens.

5. male.|Para. Schulz|4|Boite 46|. The specimen is *T. satyrus.*

6. male.|Para Schulz|5|. The specimen is *T. satyrus* and I have designated it as the type of the species.

ALPHABETIC LIST OF NAMES PROPOSED IN THE TWO GENERA

Triacanthagyna caribbea, new species.
Triacanthagyna ditzleri, new species.
Triacanthagyna needhami Martin. See text under *T. trifida.*
Triacanthagyna obscuripennis Blanch. See text under *T. septima;* not in the key to species.
Triacanthagyna (*Gynacantha*) *satyrus* Martin.
Triacanthagyna septima Selys.
Triacanthagyna trifida Rambur.
Gynacantha adela Martin.
Gynacantha (*Selysiophlebia*) *aratrix* Förster. See text under *G. chelifera;* not in the key to species.
Gynacantha auricularis Martin.
Gynacantha bifida Rambur.
Gynacantha caudata Karsch.
Gynacantha chelifera McLachlan. Not in the key to species.
Gynacantha convergens Förster.
Gynacantha croceipennis Martin.
Gynacantha ereagris Gundlach.
Gynacantha gracilis Burmeister.
Gynacantha interioris, new species.
Gynacantha jessei, new species.
Gynacantha jubilaris Navas. See text under *G. membranalis.*
Gynacantha klagesi, new species.
Gynacantha laticeps, new species.
Gynacantha limai Navas. See text under *G. convergens.*
Gynacantha litoralis, new species.
Gynacantha martini Navas. See text under *G. adela.*

Gynacantha membranalis Karsch.
Gynacantha mexicana Selys.
Gynacantha nervosa Rambur.
Gynacantha robusta Kolbe. See text under *G. bifida.*
Gynacantha (Aeshna) subviridis Selys. See text under *G. auricularis.*
Gynacantha tenuis Martin.
Gynacantha tibiata Karsch.

Species are arranged in the text in the same order as in the tabulation of venational characters as follows: *T. septima, ditzleri, caribbea, trifida, satyrus, G. laticeps, chelifera* (and *aratrix*), *adela, convergens, tenuis, caudata, tibiata, jessei, auricularis, klagesi, creagris, mexicana, nervosa, bifida, croceipennis, litoralis, interioris, gracilis,* and *membranalis.*

Key to American Species of Triacanthagyna and Gynacantha

1. Two rows of cells between M1 and M2 beginning under the stigma; fork of Rs near the proximal end of the stigma in the front wing (except in *trifida*) and more basal in the hind wing than in the front wing. Third joint of penis in ventral view elliptical, without membranous margins, from slightly shorter than to less than half as long as the second joint, and only slightly wider; ligula relatively long and narrow, in ventral view subequal in width; superior appendage with a short narrowed base, apically blade-like, with parallel or subparallel margins to near the minutely toothed apex, the blade without carinae or processes; posterior part of hamular process relatively low and therefore appearing more nearly horizontal, with no deep sulcus entirely across the process dividing it from the anterior part, which is relatively narrow. Ventral process on abdominal segment 10 of female three-pronged. So far as observed crepuscular, flying in the evening and rarely in the morning; flight very erratic. Triacanthagyna. 2.

1.′ Two rows of cells between M1 and M2 beginning at or proximal to the stigma in the hind wing and usually in the front wing; fork of Rs distinctly basal to the stigma in the front wing and more basal in the hind wing (except in *aratrix*). Third joint of penis in ventral view roughly triangular with a large expanded membranous basal margin on each side, equal to or slightly exceeding the second joint in length, and nearly or quite twice as wide; ligula relatively shorter, wider caudad, not subequal in width in ventral view; appendages variously shaped; posterior part of hamular process high and vertical or subvertical, sharply divided by a deep sulcus, which extends across the process, from the anterior part which is broad and thin. Ventral process on abdominal segment 10 of female two-pronged. Habits varied, when crepuscular, flight less erratic and often in regular beats at a uniform height.
Gynacantha. 6.

2 (1). Legs entirely pale; thorax without definite dark markings; abdomen pale; anterior edge of frons seen from above convex. Male with abdomen not constricted at segment 3; the opposing hairs on the blades of the superior appendages reduced in length from the base to the middle of the blade, the apical half with only ordinary short hairs..... .....*septima.*

2.′ Legs more or less dark, in tenerals the legs are pale but the apices of the femora and bases of the tarsi dark to black; thorax with definite dark markings; abdomen dark; anterior edge of frons seen from above more or less angled. Male with abdomen constricted at segment 3; the opposing hairs on the blades of the superior appendages about equally long and numerous the entire length of the blade.....*trifida* group. 3.

3 (2′). Anterior row of cells in anal loop usually consisting of two cells; second and third femora similar in color. Hamular process relatively small and short, less than .4 in length, equal to much less than one-third the distance from its

posterior edge to the anterior end of the median sulcus of the anterior lamina; superior appendage with the sides of the blade beyond the narrowed base parallel. Female with abdomen very slightly constricted, the space between the lateral and ventral carinae distinctly narrowed at the level of the transverse carina; appendages about as long as the last three segments.....*ditzleri.*

3'. Anterior row of cells in anal loop usually consisting of three cells. Hamular process larger, more than .4 in length, equal to more than one-third the distance from its posterior edge to the anterior end of the median sulcus of the anterior lamina. .....4.

4 (3'). Second and third femora dissimilar in color. Hamular processes with the mesal edges diverging posteriorly, less than .6 long; superior appendages with the sides of the blade beyond the base slightly converging posteriorly as seen in supero-internal view. Female with abdomen not constricted, and the appendages slightly shorter than the last three segments. .....*caribbea.*

4'. Second and third femora similar in color. Hamular processes with the mesal edges subparallel; superior appendages with the sides of the blade beyond the base parallel. Female of the single species known with the abdomen constricted at segment 3 and the appendages as long as the last three and one-half segments. ..... 5.

5 (4'). Hamular process less than .6 long; margins of genital fossa without spines. Female as described in paragraph 4'.....*trifida.*

5'. Hamular process about .7 long; posterior border of genital fossa with a large patch of black spines or teeth. Female not known. .....*satyrus.*

6 (1'). No antenodal crossveins of the first or second series, basal to the first thickened antenodal, present (rarely a single crossvein may be seen in one wing). .....7.

6'. One or more antenodal crossveins of the second series, and rarely of the first series, basal to the first thickened antenodal, present in front wings or hind wings or both; venation complex, two rows of cells between M_3 and M_4 immediately following the loop in M_4; size large, abdomen 55 or more, hind wing 55 or more, and stigma front wing 5 or longer; colors bright and contrasting; wings with a colored basal area extending to nearly the first antenodal at least; femora light, clear reddish brown to almost black with the apices dark to black, tibiae darker, the dorsal surface sometimes more or less light yellowish brown; abdomen greatly enlarged at base, constricted at 3. In the male the ventral carina on abdominal segment 2, posterior to the point of convergence, concave, meeting the lateral carina at an acute angle; spines of anterior lamina directed caudo-ventrad. Apparently on the wing throughout the day..... .....*gracilis* group. 27.

7 (6). Small to medium insects (abdomen 32-54, hind wing 32-54); dull to brilliant coloration, legs variously colored; stigma rarely 4.5 long, in which case the auricles of the male are greatly enlarged or there is a median apical tubercle on the sternum of abdominal segment 1 in both sexes; venation simple to complex; wings hyaline to tinged yellowish brown, rarely with very restricted brown at base. In the male the abdomen is constricted at segment 3 (except in *laticeps*) and the ventral carina on 2, posterior to the point of convergence, is concave, meeting the lateral carina at an acute angle; spines of anterior lamina variously directed. Habits various.....Several groups. 8.

7'. Medium to large (abdomen 43-62, hind wing 42-57, stigma front wing 4 long or longer), dull colored, brownish insects, with green if present dull or pale; sides of thorax brown with at least four usually distinctly defined brown to black spots or areas as follows: one surrounding the metastigma, a spot above

the metastigma, a spot at the upper end of the second lateral suture, and a spot or stripe posteriorly on the latero-ventral carina; legs pale colored; venation complex, two rows of cells between M_3 and M_4 immediately following the loop in M_4; wings hyaline to tinged yellowish brown or with a brown or brownish longitudinal stripe near the costal margin; sternum of abdominal segment 1 without a median apical tubercle. Auricles of male not greatly enlarged; the ventral carina on abdominal segment 2, posterior to the point of convergence, straight or convex, never concave, meeting the lateral carina in a more or less rounded angle; spines of anterior lamina directed caudad and slightly ventrad. So far as observed, flying for a short time in the evening just before dark or rarely in dark woods during the day. .....*nervosa* group. 16.

8 (7). Legs pale colored, yellowish or reddish.....9.

8′. Legs black or black and yellow, bases of femora more or less pale..... .....*tibiata* group. 15.

9 (8). No distinct brown stripe on the first lateral suture; anal loop normally separated by two or three rows of cells from the posterior wing margin. .... 10.

9′. A distinct brown stripe on the first lateral suture; anal loop separated by a single row of cells from the posterior wing margin. .....*caudata* group. 14.

10 (9). Smaller species, hind wing less than 45 in length. Auricles of male in lateral view not extending caudad to the level of the transverse carina at mid-height. In the female the lateral and ventral carinae on abdominal segment 2 subparallel. .....11.

10′. Larger species, hind wing 45 or more in length. Auricles of the male very large, expanded, in lateral view extending caudad far beyond the level of the transverse carina at mid-height; spines of anterior lamina not directed more ventrad than caudad. In the female the lateral and ventral carina on abdominal segment 2 diverging anteriorly, and the abdominal appendages shorter than the last two segments. .....*auricularis* group. 13.

11 (10). Spines of anterior lamina of male directed more ventrad than caudad. Female not as in 11′.....12.

11′. Wings not brown spotted at base. Male with spines of the anterior lamina directed more caudad than ventrad, and two cells between anal loop and anal triangle in first row posterior to A. Female with wing bases hyaline and four cells posterior to A and proximal to the anal loop. .....*adela.*

12 (11). Base of wings hyaline. Abdomen of male not constricted at 3 and in the female the distance between the lateral and ventral carina on the same segment less narrowed than in *convergens.* In the male one cell between the anal loop and the anal triangle in the first row posterior to A, and in the female three cells in the first row posterior to A and proximal to the anal loop; the smallest species.....*laticeps.*

12′. Base of wings tinged brown nearly to or slightly beyond the first antenodal. Abdomen of male constricted at 3, and in the female the distance between the lateral and ventral carinae on the same segment narrowed at the level of the transverse carina to about one-half the width posterior to this point. In the male two cells between the anal loop and the anal triangle in the first row posterior to A, and in the female four cells in the first row posterior to A and proximal to anal loop. .....*convergens.*

13 (10′). Auricles of male large, not brilliantly colored ventrally, the black edge not produced anteriorly on the ventrum to the level of the hamular process; no teeth on the ventral carina of segment 2. Female with abdomen not constricted at 3; lateral carina on 2 uniformly low throughout its length. *auricularis.*

13′. Auricles of male larger, brilliantly colored ventrally, the black edge produced anteriorly on the ventrum to the level of the hamular process; ventral carina on 2 with a row of scale-like teeth anterior to the point of convergence. Female with abdomen constricted at 3; lateral carina on 2 elevated at the point corresponding to the auricle in the male. ..... *klagesi.*

14 (9′). Male usually with a row of small scale-like teeth on the ventral carina of the second segment anterior to the point of convergence; the lateral carina on the same segment, posterior to the level of the apex of the auricle, black or dark brown. Female with the lateral and ventral carinae on abdominal segment 3 only very slightly converging just anterior to the level of the transverse carina. ..... *tenuis.*

14′. Male without teeth on the ventral carina of abdominal segment 2; lateral carina on the same segment, posterior to the level of the apex of the auricle, pale colored. Female not known. ..... *caudata.*

15 (8′). Tarsi of four posterior legs striped yellow dorsally; sternum of abdominal segment 1 with a low median posterior tubercle; abdominal appendages yellow. Apical abdominal segments of male yellow or yellowish. ..... *tibiata.*

15′. Tarsi of all the legs black or with the merest trace of yellow; no tubercle on sternum of abdominal segment 1. Apical abdominal segments and appendages of male black; female not known ..... *jessei.*

16 (7′). A wide black stripe covering the posterior third or more of the metepimeron; wings hyaline or with the merest trace of color near the costal margin. Male with the abdomen greatly constricted at segment 3. Female with the lateral carina on segment 2 distinctly black ..... *mexicana.*

16′. No distinct wide black stripe on the metepimeron. Lateral carina on segment 2 on the female not distinctly black. Males, paragraph 17; females, paragraph 22.

17 (16′). Abdominal segment 3 greatly constricted as seen in dorsal view, the lateral and ventral carinae fused or in juxtaposition at the level of the transverse carina and for a short distance anterior to that point. ..... 18.

17′. Abdominal segment 3 slightly or not constricted as seen in dorsal view, the lateral and ventral carinæ separated throughout their length ..... 20.

18 (17). Wings with a longitudinal stripe of color near the costal margin from base to apex, darker basally, shading out apically ..... *interioris.*

18′. Wings without a costal colored stripe ..... 19.

19 (18′). Smaller, hind wing 42-43, venation less complex, two rows of cells between the anal loop and the hind margin of the wing. Cuba and the Bahamas. ..... *creagris.*

19′. Larger, hind wing 48-50, venation very complex, three rows of cells between the anal loop and the hind margin of the wing. South American..... *litoralis.*

20 (17′). Wings hyaline or uniformly brownish tinged; lateral and ventral carinæ on abdominal segment 3 approaching at the level of the transverse carina, but distinctly separate and diverging anteriorly from this point..... *nervosa.*

20′. Wings with a distinct stripe of color near the costal margin; lateral and ventral carinæ on abdominal segment 3 widely separated throughout their length and only slightly approaching anterior to the level of the transverse carina ..... 21.

21 (20′). Color on wings confined to near the costal margin..... *bifida.*

21′. Wings with the entire membrane suffused with yellowish.....*croceipennis.*

22 (16′). Abdomen slightly constricted at segment 3, the space between the lateral and ventral carinæ narrowed at the level of the transverse carina to about one-half or less the maximum width between them posterior to this point....23.

22′. Abdomen not constricted at segment 3, the space between the lateral and ventral carinæ slightly or not narrowed at the level of the transverse carina.....24.

23 (22). Smaller, hind wing 43-46, venation less complex, two rows of cells between the anal loop and the hind margin of the wing. Cuba and the Bahamas..*creagris.*

23′. Larger, hind wing 55, venation more complex,three rows of cells between the anal loop and the hind margin of the wing. South America. .....*litoralis.*

24 (22′). Wings hyaline or uniformly tinged.....*nervosa.*

24′. Wings with a distinct dark stripe near the costal border.....25.

25 (24′). Wing membrane suffused with yellowish or brownish, the costal stripe bounded posteriorly by R.....*croceipennis.*

25′. Wings hyaline except the costal stripe.....26.

26 (25′). Costal color yellowish, darker to brownish at base, bounded posteriorly by R ..... *bifida.*

26′. Costal color darker, browner and wider, bounded posteriorly by M...*interioris.*

27 (6′). Colored basal wing area reduced, occupying less than half the median space and bounded posteriorly by A; T-spot on frons well marked. Male with the ventral carina on segment 2 with few to no teeth anterior to the point of convergence and a few posterior to the same point and with seven or eight denticles on the auricle.....*gracilis.*

27′. Colored basal wing area extensive, occupying all or nearly all the median space and extending posteriorly beyond A, especially in the hind wing; frons above black or obscure, no evident T-spot. Male with the ventral carina on segment 2 with a row of ten or more teeth anterior to the point of convergence and none posterior to this point, and with only three or four denticles on the auricle ..... *membranalis.*

Discussion of Species[1]

Triacanthagyna septima Selys

6, 7, 10 (female is *ditzleri*), 11, 12, 23, 25, 26, 36, 40.

Abdomen male 38-45, female 42-48; hind wing male 34-41, female 37-43; superior appendage male 4.2-5, female 5-5.2; stigma front wing 3-3.5.

Dr. Calvert has called attention to the variation in the number of cells in the anal triangle in this species. And equally surprising is the variation in both sexes in the number of rows of cells between M_4 and Mspl in the hind wing and the number of cells in the anterior row of cells in the anal loop. Of fourteen males from Puerto Barrios, six have four rows between M_4 and Mspl, seven have three, and one has four on one side, three on the other; of twelve females from the same locality nine have four rows and three have three rows. Moreover the four-rowed condition is not confined to specimens

[1] Numbers following each species refer to the citations in the bibliography.

from Guatemala, specimens from as widely separated localities as Mexico and Ecuador showing the same character. The larger number of specimens have three cells in the most anterior row of cells of the anal loop, but specimens with two cells are numerous, and asymmetrical specimens are not rare. With few exceptions there is a single row of cells throughout between M_2 and Rs but in a few cases there is a single double cell. In the males there are usually two cells just posterior to A between the anal loop and the anal triangle, rarely one; and in the female there are four cells between the anal loop and the wing base. In the male the sternum of abdominal segment 1 may be smooth or may have as many as twelve small black spines and the spines on the ventral posterior margins of 2 vary from a single row of six or seven spines on each side to a small patch of as many as sixteen spines. In contrast with these variable characters, there are three denticles on each auricle, one of these concealed on the inside of the auricle and anterior to the other two.

The wide variation in many characters, the great variation in size, and the wide distribution of the material before me, led me to expect to find two or more confused species, but I have been unable to recognize more than one species. At the same time I have been unable to identify the species *obscuripennis*. It is rather remarkable that *septima* is represented in the large de Selys collection by a single male. As recorded by Martin *obscuripennis* is represented in the same collection by two males and two females. The appendages of *obscuripennis* as figured by Martin seem relatively shorter and heavier than those of *septima*, but characters for separating the two species are not very definite. Much of the material before me has been studied by Dr. Calvert and I follow him in referring it all to *septima* but it seems to me not improbable that that name is really a synonym of *obscuripennis*. The abdominal appendages of the female of *septima* are elliptical with a low median longitudinal dorsal carina and the extreme apex acute.

My notes contain the following references to living colors: Males, Bolivar, Colombia: Eyes dark greenish brown above, gray beneath; thorax largely bright light green with few light brown markings, dorsum with a semicircular area covering the lower part; abdomen light brown, markings green and black. Female, Santa Marta, Colombia: Thorax above rich light brown, with a wide curved stripe on the mesepisternum green, wider and yellowish below, sides largely green; abdomen clove brown, markings obscure yellowish and black. Several well preserved males are colored as follows: On dorsum of thorax a lower central triangular or semicircular area, and an antehumeral stripe, which tends to fade out in the surrounding green, pale brown; sides of thorax and abdominal segments 1 and 2 and base of 3 to or beyond the transverse carina, largely green. Dorsum and sides of abdomen brown, green as follows: 1, D spot; 2, AD narrow, MD large, joined with AML, PDs separated in the midline above, and on side PD and PL not joined; 3, AL, ML, MD, PD and PL present, the two latter not joined; on 4 and progressively posteriorly the spots are smaller and more obscure, MD, the best marked, disappearing after 8; extreme base of 2-8 dark ringed.

At Puerto Barrios the large palm swamp adjoining the town had been cut off prior to 1909 for some distance back from the coast, and over this area in May and June, as darkness came on in the evenings and as darkness gave way to light in the mornings, *septima* came from the nearby forest to dart back and forth, high in the air, or near the ground, in countless thousands. But because of their erratic flight the collector found himself netting only an occasional specimen where dozens were apparently awaiting the sweep of the net. At Bolivar the following note: "This species the most erratic flier I have ever seen, and possibly the most difficult to catch. Along road after sunset. Few flying where there were many last evening. Began flying at 5:45 p. m." At Puerto Berrio, "Flying along the railroad track below the hotel about 6:10 p. m.,—almost dark." At Cienega, "A male flew into a lighted car at railroad station at 7:15 p. m.—dark outside." At Palma Sola, "Flies along railroad track and in clearings in the woods just after sundown; very erratic especially in clearings; in town along railroad tracks associated with *Gynacantha nervosa.*" At Tachira, "Flying along railroad after sundown."

Their erratic flight is due to sudden darts after their prey which they detect at some distance. In clearings and along roads or trails the sky above them is a clear bright field and I have often seen *septima* rise several feet to seize its prey. In fact, so far as I can recall, they always strike from below. I have never found them flying in the mornings except at Puerto Barrios. It seems improbable that early evening and early morning flying occur generally, for the usual great differences in day and night temperatures might be expected to prevent this.

In my field notes the reference to *septima* as the most erratic flier I have ever known should doubtless be modified. Other species of Triacanthagyna are probably as swift and erratic, and, after repeated observations one afternoon, I give the palm for abrupt and erratic and perfectly controlled flight, among all the dragonflies I know, to *Tholymis citrina.*

Material examined: *Mexico* (A. N. S. 1 male, 1 female; U. S. N. M. 1 female); *Guatemala* (Van. Patten, 1 female M. C. Z.), Puerto Barrios (May 25, 26, 28, and 30, and June 23, 1909, 16 males, 12 females E. B. W.), Santa Tomas (May 29, 1909, 1 male, E. B. W.), San Felipe (Hay and Maxon, February 22, 23, 1905, 1 male, 1 female, U. S. N. M.); *Costa Rica,* Guapiles (P. P. C., July 13, 1915, 1 female, A. N. S.); *Colombia,* Santa Marta (December 16, 1916, 2 females, E. B. W.), Bonda, Dept. Magdalena, 250 feet (H. H. Smith, July and August, 2 males, 1 female, Carn. Mus.), Bolivar, near Santa Marta (December 21, 24, 25 and 26, 5 males, 3 females, E. B. W.), Cienega, Dept. Magdalena (February 26, 1917, 1 male, E. B. W.), Rio Frio, Dept. Magdalena (January 7, 1917, 1 male, E. B. W.), Rio Neuvo, Dept. Bolivar, on Magdalena River, between Magangue and El Banco (January 22, 1917, 1 female, E. B. W.), Puerto Berrio, Dept. Antioquia (January 31 and February 21, 1917, 2 females, E. B. W.); *Ecuador,* (F. Campos R., 1 female, Cornell), Guayaquil (F. Campos R., 4 males, 2 females, A. N. S., 1 female, Ris), El Salado (F. Campos R., 1 male, 1 female, A. N. S.), S. Rafael (F. Campos R., 1 female, A. N. S.), Babahayo (F. Campos R.,

1 female, A. N. S.); *Bolivia*, Province del Sara, Dept. Sta. Cruz, 350 m (José Steinbach, February, 1913, 1 female, Acc. 5076, Carn. Mus.); *Venezuela* (Appun, 1 male, M. C. Z.), Puerto Cabello (1 female, M. C. Z.), Palma Sola, Dept. Falcon (March 4-10, 1920, 10 males, 5 females, E. B. W.), Tachira, Dept. Falcon, about 364 m (April 11, 1920, 1 male, E. B. W.); *Dutch Guiana* (1 female, O. S. U.; 1 male, U. S. N. M.; 1 female, M. C. Z.; 1 male, 1 female, Ris), Paramaraibo (K. Mayo, 1 female, A. N. S.); *French Guiana*, Cayenne (S. M. Klages, February, 1917, 3 males, 1 female, Acc. 5873, Carn. Mus.); *Brazil*, Para (February 6, 1901, 1 female, Ris; C. F. Baker, 1 female, E. B. W.), Santarem (A. H. Fassl, July, 1920, 1 female, Ris), Manaos (Miss H. B. Merrill, 2 males, 2 females, U. S. N. M.), Bom Jesus de Itabapoana, Rio Janiero (Zikan, March 26, 1906, 1 female, Ris); *Trinidad*, San Juan (March 2, 1912, 1 female, E. B. W.); *Cuba* (Poey, 1 male, 1 female, M. C. Z.). See also discussion above of specimens in the de Selys Collection.

Triacanthagyna ditzleri, new species

6 (Chapada male as *trifida*), 10 (April female and August male as *trifida*, September female as *septima*).

Abdomen male 36-40, female 41-43; hind wing male 33-36, female 37-42; superior appendage male 4.8, female 6-6.9; stigma front wing 3.4-3.6.

Male.—Living colors, from notes on the Palma Sola male, March 6, 1920. (Descriptive notes in parentheses made from preserved specimens.) Eyes above dark green, in front on either side an oblique line of bright blue, narrowly bordered on its upper edge with black especially at the superior end of the line; lower half of eyes pale green with a slight brownish cast and one conspicuous black and five or six smaller brown pseudo-pupillae. (Face green, paler and duller below, darker to black above, anteclypeus brown; frons above in front black, stem of T-spot obscure or wanting; frontal vesicle black; occiput small, green.) Rear of head greenish yellow, a broad black band from foramen to occiput.

Prothorax brown, anterior lobe blue, elevation of posterior lobe dark brown, the free edge narrowly greenish blue.

Thorax brilliant grass green, marked with rich dark brown, almost black on the dorsum; dark mid-dorsal area nipple-shaped, narrower above, the edge on either side at midheight concave then widening out and convex below. Antehumeral stripe wide, almost as dark as the dorsal area, shading out above, especially anteriorly, and very narrowly joined above with the middorsal area; two lateral narrow brown stripes, the first the wider and forked above; interalar spots green.

Abdomen above rich reddish brown, almost black, apex of 7 and 8 and 9 paler. In a male from La Fria the thorax above and the abdomen above were entirely black, not brown and not paler apically. Abdominal markings bright green as follows: 1 with D interrupted, L present; 2 with AD tapering from base to apex, AML large, MD narrow and triangular, PD narrowly divided in the mid line, PL and PD not joined, PL about the same size as PD on either side, both small; (two or three denticles on each auricle;

margins of genital fossa without spines or teeth, a small patch of short bristles on the marginal prominence opposite the posterior end of the ligula); on 3 AL triangular, reaching about half the distance to the transverse carina; 3-7 each with MD small, triangular, narrowly separated, and PD small and elliptical, both MD and PD progressively smaller posteriorly, almost gone on 7, on 8 MD represented by mere dots; ML and PL apparently wanting or very faint on 3 and posterior to that segment; AL on 4 and posteriorly inconspicuous or wanting.

(Wings hyaline, costa dark reddish brown to black, stigma dark brown, ventral surface paler and yellowish; venation black or nearly so.)

(First femora black, green behind the full length except the extreme apex, first tibiae and tarsi dark brown; middle and hind legs similar in color, femora and tibiae light to dark reddish brown, each femur paler toward the base and black at apex, each tibia dark to black at base and apex, tarsi black or nearly so.)

Female.—Based entirely on preserved material. Face yellowish brown, yellower below, darker and obscurer above with only faint tinges of green. Head above similar to the male.

Thorax similar to the male, the middorsal dark area more nearly triangular in shape, the dark colors reddish brown, paler, and the green less vivid.

Abdomen, like the thorax, paler than in the male, only the apical three or four segments apparently black or much darker than the paler basal segments. D and L present on 1, the latter large; 2 with AML, MD and PL joined into a long wide longitudinal bar just above the lateral carina; on 3 AL and ML joined, and the other spots, MD, PD and PL, present; 4 with the five spots, AL, ML, MD, PD and PL all present, though small; these spots can all be detected on 5 and 6, and in life doubtless some of them are continued farther posteriorly. Appendages regularly elliptical, widest about the middle, maximum width .9-1.0, a low median longitudinal dorsal carina, apex regularly rounded, extreme apex acute.

Wings and legs as in the male.

Of fourteen wings of males, twelve had two cells in the most anterior row in the anal loop, and two wings had three cells; of fourteen wings of females nine had two cells and five had three cells. In the males there were invariably two cells just posterior to A between the anal loop and the anal triangle; and in the females there were in every case four cells posterior to A from wing base to anal loop. Of both sexes twenty-three front wings had a single row of cells throughout between M_2 and Rs, three wings had a single double cell, and two wings had two-three double cells; in the twenty-eight hind wings all had a single row of cells between M_2 and Rs.

Ditzleri is the smallest and possibly the handsomest of the *trifida* group, and the smallest specimens are smaller than the smallest *septima* I have seen. However, the male from Blumenau, referred to this species, is larger than the measurements given above, the abdomen being 42.5 and the hind wing 40. The wings are slightly tinged brownish; there are two cells in the anterior

row in the anal loop. The second and third legs are darker than usual, the reddish brown of the femora being darker with the apical black more extensive. But I believe the species is certainly *ditzleri*.

Several evenings at Palma Sola, returning home about sunset, walking on the railroad track through the practically continuous forest which surrounds the village, suddenly before us, near at hand and as far as we could see down the track, would appear the widely darting forms of Triacanthagynas. Even when seen in numbers each individual's flight was too erratic and independent to permit calling the assemblage a flock. One evening they were especially numerous. We tried striking at individuals, and we ran down the track beating back and forth with the net, but two of us doing our best failed to catch a single one. Returning later one evening I ran along the track striking right and left as rapidly as possible and thus by sheer good fortune netted two individuals, a male each of *ditzleri* and of *caribbea*. The single specimen taken at Puerto Barrios was associated with *T. septima*. I had been catching specimens of *septima* since about sundown and when *ditzleri* was captured it had grown so dark I could see individuals only when they came between me and the clear sky. I think all the other specimens of *ditzleri* we captured were taken in the forest where, when flushed, they usually flew a short distance and alighted on some twig or stem, or even tree trunk, in characteristic aeshnine position with down-hanging abdomen.

Material examined: *Guatemala,* Cayuga (Schaus and Barnes, April, 1 female, August 27, 1 male, September 16, 1 female, A. N. S.; first two recorded, Calvert 10, as *T. trifida,* the female of September 16 as *septima*), Puerto Barrios (June 23, 1909, 1 male, E. B. W.); *Colombia,* Puerto Berrio, Dept. Antioquia (January 31 and February 8 and 21, 1917, 3 males, 3 females, E. B. W.); *Venezuela,* Palma Sola, Dept. Falcon, (March 6, 1920, 1 male, E. B. W.), El Guayabo, Dept. Falcon (April 22, 1920, 1 male, E. B. W.), La Fria Dept., Falcon (April 12, 13, 16 and 17, 1920, 4 males, 2 females, E. B. W.); *British Guiana,* Bartica (H. S. Parish, May 28 and June 1, 1901, 2 males, O. S. U.); *Dutch Guiana* (1 male, 1 female, O. S. U.; 1 male, det. by R. Martin as *trifida,* Ris; 1 male, E. B. W.), Paramaraibo (Miss K. Mayo, 1 female, A. N. S.); *Brazil,* Para (C. F. Baker, 1 female, E. B. W.), Tapajos, Amazon, Monte Christo (A. H. Fassl, May, 1920, 1 female, Ris), Porto Alegre, Rio Grande de Sul (J. D. Haseman, January 21, 1909, 1 male, Acc. 3768, Carn. Mus.), Blumenau, Santa Catharina, (1 male, E. B. W.), Chapada (1 male M. C. Z., recorded, Calvert 6, as *trifida*). See also discussion above of specimens in the de Selys' Collection. Type male and allotype female, La Fria, Venezuela, April 17, 1920, E. B. W. Named for William Howard Ditzler, who, as a member of the University of Michigan Venezuelan Expedition collected, among many other dragonflies, the type of this handsome species.

Needham's Figure 3, Plate XXXIX. A Genealogic Study of Dragon-Fly Venation, is probably of the wings of this species.

Triacanthagyna caribbea, new species

6, 10, 11, all in part. See text.

Abdomen male 41-45, female 44-47; hind wing male 39-45, female 42-46; superior appendage male 5.4-5.7, female 6.9; stigma front wing 3.5-4.2.

Male.—Living colors, from notes on the Palma Sola male, March 6, 1920. (Descriptive notes in parentheses made from preserved specimens.) Very much like *T. ditzleri;* head above darker green, the black line, bordering the blue bar across the eyes, is itself narrowly bordered above with light green, and the blue bar itself below passes through darker blue to black; rear of head with very nearly white replacing the greenish yellow.

Prothorax almost white, posterior lobe darker.

Thorax less brilliant green but still very bright; dark markings reddish brown, less contrasted with the green as compared with *T. ditzleri,* but still very distinct, the dorsal dark area more widely connected with antehumeral stripe, thus more isolating the dorsal green.

Abdomen brown, much paler than in *T. ditzleri;* on 2 PL is large, quadrangular, twice as wide as PD above it, and joined with the auricle, not so joined in *T. ditzleri;* (three denticles or three and the vestige of a fourth on each auricle; one to nine, usually four to six, small teeth of varying sizes on the margin of the genital fossa on the prominence opposite the posterior end of the ligula); on 3 AL larger, reaching the transverse carina; 3-8 with ML present as small pale yellowish brown spots; MD and PD still conspicuous on 7; on 8 as conspicuous as on 7 in *T. ditzleri;* PD represented on 9 by small spots.

(Wings hyaline to brownish tinged, costa dark reddish brown to almost black at apex, stigma reddish brown, beneath lighter yellowish brown, venation black or nearly so.)

(First and second femora black or nearly so, paler at base and green behind, the two similar in color, thus different from *ditzleri* where the second and third legs are similarly colored; third femora black, or nearly so, thus distinctly darker than in *T. ditzleri;* tibiae black beneath, reddish brown above; tarsi black.)

A teneral male, Santa Marta, December 14, 1916, in life was colored as follows: Eyes above dark brown. Dorsum of thorax bright brown, stripes bright green and distinct; sides green with brown markings in definite pattern. Abdomen brown, markings black (at the extreme apex of each segment from 3 posteriorly to about 7), and (spotted) obscure yellow. (In this specimen the third femora are dark brown and the contrast between the second and third femora is as well marked as in adults.)

The following notes on living colors were made on an apparently adult male, Bolivar, Colombia, December 21, 1916: Colors of thorax bright green and rich brown in distinct and sharp pattern. Abdomen brown with green and black markings.

Female.—Based on preserved material. Face light yellowish brown, darker above, with only faint traces of green; frons above dark dull green shading into black anteriorly, with the stem of the T-spot obscure or wanting, as in the male.

Thorax and abdomen as in the male, to judge from preserved material, the colors possibly slightly paler, especially those of the abdomen. Appendages similar to *ditzleri* in shape, basal narrowing slightly longer.

Wings and legs as in the male.

Of fourteen wings of males twelve had three cells in the most anterior row in the anal loop, and two wings had two cells; of fourteen wings of females all had three cells. In thirteen wings of males there were two cells just posterior to A between the anal loop and the anal triangle, and in one wing there were three cells; in the fourteen wings of females there were in every case four cells posterior to A from wing base to anal loop. Twenty-two of the twenty-eight front wings had one row of cells throughout between M_2 and Rs, four wings of females had a single double cell, and one wing of each sex had two double cells; in all twenty-eight hind wings there were invariably a single row of cells.

In a dry brush-choked gully near Santa Marta we found slightly teneral specimens of this species in December. Crawling about through the almost impenetrable spiny vegetation the collector flushed occasional individuals, a few of which it was possible to capture in his fingers. Other specimens were taken soon after sunset flying along the road at Bolivar and other specimens from various localities were flushed in forests.

Caribbea, in the form of the superior appendages of the male, differs from the other three species of the *trifida* group, but this difference is slight and will be detected probably only by those having specimens of the several species for comparison. The green color of the posterior surface of the second femora, which thus resemble the first femora and differ markedly from the third femora, is obvious in well colored specimens of both sexes. In teneral individuals this green is replaced by gray and the color is less conspicious as the entire femur is paler in such specimens. But in these cases the third femora are darker than the second, so the dissimilarity between the second and third femora still holds. In *trifida* Rs forks more basally than in other species of the group and this can be more readily detected in the front wing (because of the greater proximity of the fork to the stigma) than in the hind wing. In figure 146, Martin 25, *trifida,* Rs in the front wing forks basal to the level of the last postnodal crossvein, and in the hind wing basal to the level of the stigma a distance equal to or greater than the length of the stigma. A comparison of Martin's figure 146 with figure 3 of *caribbea* in this paper will show this difference, which however, like the differences in appendages, is difficult of precise definition. See last paragraph under *T. ditzleri.*

Material examined: *Mexico* (1 male, 1 female, U. S. N. M.); *Guatemala,* Cayuga (Schaus and Barnes, forest, August 23, 1 female, A. N. S.); *Colombia,* (Turbo, Mack, 1 male, M. C. Z.), Santa Marta, Dept. Magdalena (December 13, 14 and 16, 1916, 9 males, 9 females, E. B. W.), Bolivar, near Santa Marta (December 21, 23, 26, 1916, 2 males, 1 female, E. B. W.); Puerto Berrio, Dept. Antioquia (February 8, 1917, 1 female, E. B. W.); *Venezuela,* Caracas (Rolle, 1910, 1 female, Ris), San Esteban, Dept. Carabobo (February 8, 1920, 1 female, E. B. W.), Palma Sola, Dept. Falcon

(March 4, 6 and 9, 1920, 1 male, 3 females, 1 female shot by H. B. Baker in forest, E. B. W.); Boqueron, Dept. Yaracuy (March 16, 1920, 1 male, E. B. W.), Aroa, Dept. Yaracuy (March 14, 1920, 1 female shot by H. B. Baker in forest, E. B. W.); *Dutch Guiana* (Thorey, 1 male, M. C. Z.); *Brazil*, (Heyer, 1 male, labelled "*Gynacantha elata* Hagen", and 1 male labelled "*Aeschna augusta* Hagen," M. C. Z.), Bom Jesus de Itabapoana, Rio Janeiro (Zikan, July 27, 1905, 1 female, Ris). The single specimen from Guatemala is recorded as *trifida* in Calvert 10; and the five males and one female from Mexico, Colombia (Turbo), Dutch Guiana, and Brazil (Heyer, M. C. Z.) are recorded as the same species in Calvert 6 and 11. See also discussion above of specimens in the de Selys Collection. Type male and allotype female, Palma Sola, Venezuela, March 6, 1920, E. B. W.

It should be noted that some of the above material is teneral and otherwise in a bad state of preservation, making determinations difficult, and the female of *T. satyrus* is not known and may be confused as a female of this or other species. For these reasons the records for Mexico, Guatemala, and Rio Janeiro, Brazil, are open to question.

Triacanthagyna trifida Rambur

1, 2, 5, 6 (Chapada male is *ditzleri;* Mexico, Colombia, Dutch Guiana and Brazil [Heyer] specimens are *caribbea*), 8 (is *satyrus*), 9 (is *satyrus*), 10 (male and April female are *ditzleri;* August female is *caribbea*), 11 (see 6 above), 12, 13, 16, 20, 23, 25, 26, 34, 35, 36, 39; all references in the literature to specimens outside the range of *T. trifida,* as indicated in the material studied in this paper, are probably to some other species than *trifida.*

Abdomen male 42-45, female 47-50; hind wing male 41-43, female 44-47; superior appendage male 6-6.3, female 9-10.6; stigma front wing 3.3-4.2.

I have seen only preserved material. The coloration is essentially the same as in *T. ditzleri,* but the dark dorsal thoracic area, in those specimens where the pattern is discernible, is triangular, with the lateral edges nearly or quite straight, not nipple-shaped as in *T. ditzleri.*

The wings are hyaline to yellowish brownish tinged. Twelve wings of males and twelve wings of females each had three cells in the most anterior row of the anal loop. In the males there were invariably two cells just posterior to A between the anal loop and the anal triangle, and in the female there were four cells posterior to A between the wing base and the anal loop. In three front wings of males one front wing of a female and two hind wings of males there was in each case a single double cell between M_2 and Rs; in all the other wings there was a single row of cells throughout. For a note on the basal forking of Rs see text under *T. caribbea.* See also last paragraph of text under *T. ditzleri.*

In the specimens examined there were no spines or teeth on the ventral margins of abdominal segment 2 in the male, and the auricles were armed each with three denticles or with three and the vestige of a fourth. Appendages of female elliptical, a low median longitudinal carina, of nearly uniform width throughout after the gradually tapering basal third; apex rather abruptly rounded, extreme apex acute, maximum width 1.3.

Material examined: *California* (1 male, 1 female, A. N. S.); *Georgia,* Billy's Island, Okefenoke Swamp (June, 1912, 1 male, Cornell); St. Simons Isl. (Sept., Oct., 1910, 1 female, Cornell); *Florida,* Lakeland (W. T. Davis, November 8 and 10, 1911, 2 females, W. T. Davis), Hastings (1 female, Cornell), St. Augustine (C. W. Johnson, 1 male, A. N. S.), Miami (1 female, Cornell); *Cuba,* (Poey ,1858, 1 male, 1 female, M. C. Z.), Havana (C. F. Baker, 1 male A. N. S.), Guanajay (Palmer and Riley, May 6, 1 male, 1 female, U. S. N. M.), Baraca (Aug. Busck, September, 1901, 1 male, U. S. N. M.); *Hayti* (Dr. Abbott, 1 male, A. N. S.), Samana (Frazar, 2 males, 1 female, M. C. Z.), Tortuga, N. W. Hayti (W. L. Abbott, July, 1917, 1 female, A. N. S.); *Jamaica,* Bath (Mrs. Swainson, 1 male, 1 female, A. N. S.). See also discussion above of specimens in the de Selys Collection.

Triacanthagyna needhami Martin is a synonym of *T. trifida* unless another species, which I have not seen, inhabits Florida.

Triacanthagyna satyrus Martin

8, 9, under both titles as *trifida,* 25, 26.

Abdomen male 42-43,? female 43; hind wing male 39-42,? female 41; superior appendage male 6-6.3,? female 7.8; stigma front wing 3.6-4.

Male.—Colored like *T. ditzleri* except that on abdominal segment 3 ML and PL are evident in the preserved material, and these spots may have been present on segments posterior to 3 during life. Like *T. ditzleri* it is darker than *T. caribbea,* and the following note was made of the La Fria male at time of capture. Thorax and abdomen above black, not brown, and not paler apically in the case of the abdomen. The frons above is dark to entirely black.

Dr. Calvert has kindly given me the following notes on the living colors of the Costa Rican male taken by him. Eyes brilliant green, darker above. Frons dark brown with an ill-defined superior black spot. Clypeus and labrum pale green, the latter more yellowish; labium pale brown but with some pale green on the middle of the lobes. Thoracic dorsum dark brown with a cuneiform, sharply marked, green antehumeral stripe, diverging from above from its fellow of the opposite side. Sides of thorax bright green, a narrow brown stripe on the first and second lateral sutures. Abdomen black, the following green; on 1 a transverse posterior dorsal, and on each side a transverse posterior lateral stripe, the three not confluent; on 2 each side a transverse anterior stripe, a narrow median transverse line, three posterior spots arranged in a transverse line, a mid-dorsal line and the auricles; on 3 a basal spot each side; on 3-7 each with a pair of transverse triangular spots just posterior to the transverse carina; on 3-5 a pair of transverse posterior spots. Pectus and under side of abdomen pale flesh color.

A teneral female from Rio Janeiro, Collection Ris, may belong to this species, and the above measurements of the female are based on this specimen. Although pale and faded it has plainly the leg colors of the *trifida* group and the third abdominal segment is constricted as in *T. trifida.* The

slightly shorter appendages alone distinguish it from the geographically widely separated *T. trifida.*

In the three males available and in the single female provisionally referred to this species there are invariably three cells in the anterior row of cells in the anal loop; in the male there are two cells posterior to A between the anal loop and the anal triangle, and in the female there are four cells posterior to A between the wing base and the anal loop; in the front wings of males, one wing has a single double cell between M_2 and Rs, two wings have three double cells, and one wing has four double cells; in all the other wings of both sexes there is a single row of cells throughout between M_2 and Rs.

The auricles of the second segment of the male are each armed with three denticles or with three and the vestige of a fourth.

Material examined: *Costa Rica,* Banana River (P. P. C., forest, upper reservoir, November 9, 1909, one male, A. N. S.); *Venezuela,* La Fria, Dept. Tachira (in forest, April 17, 1920, 1 male, E. B. W.); *British Guiana,* Bartica (H. S. Parish, May 27, 1901, 1 male, O. S. U.). See also discussion above of specimens in the de Selys Collection, where Martin's six types of *satyrus* are considered in detail. As explained there, these types were received for study long after this paper was completed. During the preparation of this paper Mons. Severin kindly sent me one of the types of *satyrus,* but this one happened to be the Santo Domingo specimen. On the basis of this examination *satyrus* was reduced to a synonym of *trifida* in my paper, and I described my material as a new species. With the examination of all six of Martin's types it is now possible to save his species and I have designated one of these specimens as the type of *satyrus.*

Gynacantha laticeps, new species

Abdomen male 33-33.5, female 35-38; hind wing male 32, female 34-37; superior appendage male 4.5; stigma front wing 2.25-3.

Male and female.—Labium and face dull pale yellow, slightly darker above, and occupying most of the frons above, which has a darker greenish shade, so the brown T-spot is reduced and inconspicuous; frontal vesicle dark brown; occiput greenish yellow; rear of head dull pale yellow, black margining the eyes above, and this joined with a broad black bar to the foramen.

Prothorax pale brown or greenish brown, the posterior edge yellowish green.

Thorax green; if any markings are present in life they have not survived post-mortem changes.

Abdomen not constricted, brown or yellowish brown, marked with pale (green or yellow or both) and black; 1 and sides of 2 apparently largely green, 1 darker above apically; 2 with AD very narrow and extending from the base to and across the subapical transverse carina, but ending before the extreme margin of the segment and interrupted at the median transverse carina; a basal trace of AD on 3; MD present as a triangular spot on either side on 2-7; sides of 2-7 slightly if any paler than the dorsa, no definite

pattern of dark and pale in the dried material; median transverse carina, subapical transverse carina, and extreme apex of 2-7, and to a lesser extent of 8 distinctly black ringed; 8-10 and appendages brown, slightly darker than the segments basal to them. Margins of genital fossa of 2 without teeth or spines; auricles small, armed with five to seven denticles.

Wings hyaline; costa, venation and stigma brown or yellowish brown to nearly black; the stigma in the females is lighter yellowish, due probably to immaturity, and the posterior vein, especially, is conspicuously black. In the two males and two females, of all the wings, there is, in each wing, a single row of cells throughout between M_2 and Rs; in all the wings the loop in M_4 is greatly reduced and in the wings of the two males and one of the females there is, in each wing, a single row of cells throughout between M_3 and M_4; in the other female in each front wing there is one double cell and in each hind wing there are three to five double cells.

Legs pale dull yellow, unmarked, the first femora slightly darker above.

The two females show a marked difference in size of all parts but I cannot separate them on any other character.

Material examined: *Brazil*, Minas Geraes (I. Rolle, 1914, 2 males, 2 females, Ris), type male and allotype female of this material. I am able to describe this species through the kindness of Dr. Ris who loaned me the four specimens I have seen, and who expressed the opinion, when the specimens were sent to me, that they represented an undescribed species.

Gynacantha chelifera McLachlan

25, 26, 27.

Gynacantha (Selysiophlebia) aratrix Förster

14, 25, 26.

Unfortunately I have not seen specimens of these species. They are about of the same size (abdomen 40-43, hind wing 35-37, Martin, 25), and the descriptions and figures of appendages indicate very closely related if not identical, species. In fact, with this evidence alone before me, I regard *aratrix* as a synonym of *chelifera*.

Gynacantha adela Martin

25, 26, 35.

Abdomen male 44-45, female 44; hind wing male 42-43, female 43; superior appendage male 5.1; stigma front wing 2.7-3.

The margins of the genital fossa of the second abdominal segment of the male are armed on either side, just anterior to the point of convergence, with three to six small scale-like teeth in a single row; the auricles are each armed with six or seven denticles. In one of the males from Bolivia in the left front and hind wing M_3, distal to the loop in M_4, is switched anteriorly one row of cells, resulting in three rows of cells between M_3 and M_4. This

is the only case I have seen in all the wings studied in which a main sector is so switched. The appendages of the single female are broken.

Material examined: *Peru,* Campamiento, Colonia del Perene (W. T. M. Forbes, June 12, 1920, 1 female, Cornell); *Bolivia,* near Coroico, Yungas (W. J. Gerhard, May 2, 4, and 12, 1899, 3 males, A. N. S.); *Brazil,* Minas Geraes (Rolle, 1914, 1 male, Ris). See also discussion above of specimens in the de Selys Collection.

Navas (29) describes a male from Sao Paulo as a new species, *G. martini.* His figures of appendages indicate that the inferior is relatively slightly longer than in specimens of *adela* seen by me, but definite characters for separating the two species are not evident and it is probable *martini* is a synonym of *adela.*

Gynacantha convergens Förster

15, 17, 26, 35.

Abdomen male 42, female 44-45; hind wing male 38, female 41-41.5; superior appendage male 4.8; stigma front wing 3.3.

I follow Dr. Ris's determination of this species. The margins of the genital fossa of the second abdominal segment of the male are without teeth or denticles. The auricles are each armed with five to seven denticles, of which the two or three most anterior ones are very small. Between M_2 and Rs in the front wing there is one double cell in two male wings and one female wing, two-three double cells in one female wing, three double cells in one female wing, and four double cells in one female wing; in the hind wing there are no double cells in two male wings, one double cell in two female wings, one-two double cells in one female wing, and two-three double cells in one female wing. Appendages of both females broken.

Material examined: *Bolivia,* Province del Sara, Dept. Santa Cruz, 450 m (José Steinbach, 1918, 1 female, Acc. 6443, Carn. Mus.); *Argentina,* Yuto, Jujuy 450 m (P. Joergensen, April, 1911, 1 male, 1 female, Ris).

Navas (32) describes a single female from Italiba, Brazil, as *Gynacantha limai.* From the very nature of the case positive identification is impossible, but I believe *limai* will prove to be a synonym of *convergens.*

Gynacantha tenuis Martin

25, 26.

Abdomen male 38.5-44, female 41-47; hind wing male 39-41.5, female 38-46; superior appendage male 4.2-4.4, female 3.2-3.6; stigma front wing 3.2-3.4.

Specimens in the M. C. Z. labelled *tenuis* by Hagen make the determination of this species certain. In Martin's description (25) his figure 178 is certainly *tenuis.* In the last paragraph of his text he says "L'aile de l'individu figuré porte exceptionnellement deux rangs de cellules sous la boucle anale." Presumably this remark applies to the specimen of which the appendages are figured, figure 179. It is doubtful if figure 179 is really *tenuis* as it does not agree well and really much more resembles *auricularis.*

Moreover Martin's description of the female appendages as "extrêmement longs" is hardly applicable, and there is the absence, in the description of the male, of the broad mid-lateral brown thoracic stripe, so I am inclined to believe more than one species is included under *tenuis* in the de Selys Collection.

The wings are hyaline to lightly brown tinged. In the male the margins of the genital fossa on abdominal segment 2, anterior to the point of convergence, have on either side from none to thirteen small scale-like teeth. When these teeth are present in numbers they are in a single irregular row. Posterior to the point of convergence there are none to two similar teeth. The auricles on the same segment are each armed with five to nine denticles. The abdominal appendage of the female is linear widening very slightly from the base to about five-sixth the length from which point it tapers symmetrically to the acute apex; maximum width .36-.4.

The following color notes were made from the freshly killed Tachira male. Eyes above dark green, shading below into paler green and grayish with black pseudopupillae. Prothorax pale flesh brown, hind lobe brown. Mesepisternum with inner half green, outer half brown, a rich brown mesothoracic collar, continuous with narrow middorsal brown, this collar narrowly bordered in front with green; mesepimeron, metepisternum and metepimeron green; a dark brown, almost black stripe between the mesepimeron and metepisternum, and a brown stripe between the metepisternum and metepimeron. Three anterior interalar sclerites on each side and those between these, green or greenish; the others blue. Abdominal segment 1 brown, pale basally, darker apically; 2 brown above, a longitudinal middorsal green stripe wider basally and at midlength, and passing apically into a wide transverse trilobed blue band, on either side a basal spot and a median triangular spot, green; 3 and 4 with MD present, small and green; 3 with PD present and blue; 3-8 with ML present, greenish or yellowish; AL present on 3, blue, reaching the transverse carina; 8-9 with a dorsal median yellowish spot on either side.

The following notes were made on the living colors of the female taken at Cristalina. Eyes dark green, almost brown above, paler to greenish gray beneath. Dorsum of thorax green, divided in the middorsal line and bordered below with brown; the dorsal green fades out behind into a wide brown antehumeral stripe; behind this, on the mesepimeron, is a pale greenish stripe three-fourths as wide as the antehumeral brown stripe; behind the green stripe is a very distinct dark brown stripe one-third as wide as the pale stripe anterior to it. Abdomen brown, green and black markings small, not evident on 7-10.

As we observed *tenuis* at La Fria it was on the wing through the day. It frequented dense forests and was usually found hunting about, with apparently relatively weak flight and much poising, in knee-high vegetation, usually of rather thick growth. In such locations it frequently alighted on vertical stems within a few inches of the ground. In the same forest we found *Triacanthagyna ditzleri* and *Gynacantha tibiata, gracilis* and *membranalis*. Thinking there might be some twilight fliers, we waited one

evening, near some favorable looking openings in the forest, till it was quite dark without seeing a dragonfly. In this forest palms were dominant, with some exogens, many of large size and a few giant ceibas, and more rarely a small wild cacao, and many vines and scattered areas of heliconias of varying extent.

Material examined: *Colombia,* Cristalina, Dept. Antioquia (February 16, 1917, 1 female, E. B. W.); *Peru,* Iquitos (H. S. Parish, May 11, 1920, 1 male, E. B. W.), El Encanto, Rio Caraparana, Putumayo Dist. (W. T. M. Forbes, August 25, 1920, 1 male, Cornell); *Venezuela,* Tachira, Dept. Tachira (April 6 and 8, 1920, 2 males, 1 female, E. B. W.), La Fria, Dept. Tachira (April 12-18, 1920, 19 males, 4 females, E. B. W.); *French Guiana,* Tamanoir, Mana River (S. M. Klages, May and June, 1917, 2 males, 3 females, Acc. 6008, Carn. Mus.); in the M. C. Z. are 3 males and 3 females; one female bears the label "Essequibo (British Guiana), Schneider"; two females each bear the label "Chapada (Brazil)"; two males bear the label "America," one an additional label "Charp"; a large blue label, "tenuis, n. sp. Hagen," and a label "Gynacantha Rambur"; the remaining male has a single label "176."

Gynacantha caudata Karsch

22.

Abdomen male 40-41; hind wing male 40-41; superior appendage male 4.2-4.3; stigma front wing 3.

As compared with Karsch's description of a single male the following may be noted. Face is greenish above. Thorax very similar to that of *tenuis,* the brown outer part of the mesepisternum wider than the green inner part, and also the dark stripe between the mesepimeron and metepisternum wider than in *tenuis.* Abdomen apparently brown, extreme apex of 1-7 and 10 black; 1 with L well developed and D probably present; 2 with AD, MD, PD, AML and PL present, AML developed basally well onto the dorsum, PD and PL narrowly separated; margins of genital fossa without spines or teeth, auricles with seven to nine denticles, the anterior ones very small, increasing in size posteriorly; 3 with AL, MD, and ML clearly present, all reduced, MD and ML joined, both narrow, probably apical spots are present in life on this and succeeding segments, but these cannot be detected on any of these segments in the single preserved specimen before me; 4-6 with AL, MD, and ML present, MD and ML separated or very narrowly joined, AL small and narrow, not produced posteriorly in its lower part; AL the only spots to be detected on 7.

Material examined: *Ecuador,* San Rafael (F. Campos R., 1 male, A. N. S.).

Gynacanthya tibiata Karsch

6, 9, 10, 22, 25, 26, 27, 36.

Abdomen male 41-50, female 51-53.5; hind wing male 41-50, female 50-53; superior appendage male 5-5.4, female 7-7.5; stigma front wing 3-4.5.

This is the most brilliantly colored of the American Gynacanthas. In keeping with this it is an especially alert and wary species apparently not at all crepuscular in its habits. Dr. Calvert's male (9) was taken during the day (before 4 p. m.), and at La Fria it was observed from about 9 a. m. to 4 p. m. Several were seen but in spite of our best efforts we succeeded in taking only a single male, though two days, after the capture of this single male, were practically given to search for this species. At La Fria the heavy tropical forest north of town covered the nearly level surface in a great unbroken stretch of dense verdure. Through this forest, at the season we collected there, odonate life was widely distributed with no concentrating at suitable spots such as streams or permanent pools. When odonate life is so scattered in the temperate regions, even where agriculture or natural conditions permit easy access to all parts of the dragonfly domain, it is a matter of common knowledge that the capture of specimens is difficult or well nigh impossible. To appreciate some of our difficulties in the search for *tibiata,* instead of the varied landscape of an agricultural region with its regular fields and wood lots and its section-line roads, where the collector searches possibly in vain for Ophiogomphus, imagine the unbroken and unknown expanse of an almost impenetrable forest with its somber twilight and brooding silence. In such a forest we found *tibiata.* One would suddenly appear alighting on a bush twig twenty feet away. A movement would be made towards it and it disappeared as quickly as it had come. The collector resumes his aimless wandering, an hour passes before another one is seen and the experience repeated, or night may come without another one having put in an appearance. The four of us in several days saw less than a dozen specimens. At another season conditions might well be very different. When the rains have started little streams through the forest, and when some of the muddy depressions have become ponds, the capture of *tibiata* may be a less difficult matter. When we saw them they ranged freely through the forest, flying at varying heights and resting on twigs from four or five feet to ten or twelve feet high without any of the effort at concealment which Gynacantha so often shows and which Dr. Calvert has well described (9, p. 315). Sometimes at rest the abdomen was more nearly horizontal than vertical, and at such times the yellow tipped abdomen and the position strongly suggested a gomphine rather than an aeshnine.

Dr. Calvert has described the living male from Peralta, March 23, 1910, as follows: Eyes bright green above, yellowish green below, posteriorly narrowly edged with blue; three horizontal rows of pseudopupillae visible in profile view. Frons above blue on each side of the T-spot, green anteriorly, as also are clypeus, lips, basis of mandibles, thorax, abdominal segment 1, basal half of 2 and much of 3-5. Blue as follows: rear of head inferiorly, interalar region of hing wings, auricles, posterior half of 2, and each side of the base of 3, which latter merges gradually into the green. Dark brown or black as follows: rear of head superiorly, a transverse stripe just behind the auricles, and another apical one on 2, a middorsal line, an apical transverse stripe, and a transverse stripe at the median carina on 3-7, and a transverse stripe at five-sixths the length on

3-6; 8 and 9 pale reddish brown with a pair of transverse green streaks near the base of each; 10 and appendages yellow; 6 and 7 are greenish anteriorly merging into brown posteriorly. Legs black, first and second femora inferiorly, and second and third tibiae superiorly, pale green. When this insect was flying the chief color effects were the green of the head and thorax, and orange at the end of the abdomen due to a blending of the red of 8 and 9 and the yellow of 10 and the appendages. It would poise in the same spot in the air for a minute or so at a time and at five to ten inches above the ground which was a somewhat muddy piece of grassy road. Twice I struck at it and came very near it, but it flew swiftly away only to a short distance, soon returning to a spot near where I had struck at it. (Many male Anisoptera, following copulation, will return to the spot where they captured their ovipositing mate, certainly associating the place with the capture, and again seeking the female there.—E. B. W.)

The following notes on living colors were made on the male captured April 13 at La Fria: Eyes bright dark green above, paler in front, bluish posteriorly (not rear of head), and gray beneath with one black and several brown pseudopupillae. Labrum almost white, face pale bluish, darkening above; frons above blue, T-spot black; rear of head above narrowly shining black, a broad black band to the foramen, remainder very light blue, darker above, white below.

Front lobe of prothorax almost white, middle and hind lobes brown, the latter narrowly green edged behind. Thorax bright green, a small brown area below on the mes-and metepimeron; middorsal carina narrowly dark reddish brown; interalar sclerites green, except the two posterior median ones and the one on either side between these two on the wing base, which four are bright blue.

Abdominal segment 1 green, light brown above on the apical half; 2 green below and beneath the auricles, above green at base, a longitudinal median bar, green in front and shading into blue behind where it passes into a broad transverse bar of blue which is bordered posteriorly with black; auricles bright blue above; above each auricle is a broad brown area not quite divided by a transverse green bar which is slightly wider above; anteriorly this brown area shades out into the basal green; (none to four small denticles in a scattering row on the converging margins of the genital fossa; auricles with five to six denticles); abdomen passing progressively posteriorly from a rich brown and bright green coloration to a dull orange color on 8 and 9, and light yellow on 10 and appendages; 3-7 with a very narrow longitudinal middorsal brown stripe which disappears progressively posteriorly; 3-10 beneath yellow; 3 on either side at base blue, remainder above green, shaded posterior to the transverse carina with light reddish brown, on either side a small triangular median and a larger rounded subapical bright green spot; 4 similar, but lacking the basal blue and the posterior brown shading more extensive; 5-7 similar to 4, the area posterior to the transverse carina brown, and therefore progressively posteriorly occupying more of each segment, all with four green spots as described for 3, except the apical spots which have disappeared on 7; 8 light

reddish brown or dull orange with only a trace of the median green spots and the apical spots wanting; sides of 3-8 light golden brown, shaded with darker and with green; base of 3 blue; a distinct green spot below, posterior to the transverse carina on 3-9, faintest on 9.

Material examined: *Mexico*, Colima (Rolle, 1913, 1 male, Ris), Cordoba (F. Knab, December 24, 1907, 1 female, U. S. N. M.); *Costa Rica*, Cimarones (C. H. Lankester, April 8, 1 male, A. N. S.), Ontario Farm (C. H. Lankester, September 16 and 17, 2 males, A. N. S.); *Venezuela*, La Fria, Dept. Tachira (April 13, 1920, 1 male, E. B. W.).

Gynacantha jessei, new species

Abdomen male 47; hind wing male 43; superior appendage male 5.4; stigma front wing male 3.6.

Male.—The following description is based on the single known specimen. Notes on living colors were made at the time of capture and these notes form the basis of the description, other notes based on the well preserved specimen being included in parentheses. Eyes above very dark blue, shading into paler dull blue at midheight, the lower third gray. Frons above light yellowish brown, T-spot large, face light greenish brown, labrum blue (labium dingy greenish yellow; labrum dingy blue at base shading out to dingy orange at the margins; anteclypeus dingy greenish yellow; face green in front, bluish on either side next the eyes; frons above and frontal vesicle black, the frons on either side with a narrow transverse blue bar, which is a dorsal continuation of the lateral blue of the face, thus forming a T-spot, with the cross-bar in the midline almost as wide as long, and a stem as wide as long; occiput small, greenish, darker in front, paler and clearer behind; rear of head pale yellowish, narrowly shining black above, and a broad band from this to the foramen).

(Front lobe of prothorax pale, middle lobe brownish, hind lobe brownish, pale margined behind.)

Thorax bright green with the following narrowly lined brown: middorsal carina, humeral and first and second lateral sutures; the lower end of the middorsal brown stripe has two cross bars of the same color, the inferior one of these is the longer and has the ends turned upward; metepimeron with the upper third blue, shading below into green; interalar spots between the front wings green, between the hind wings blue; (in the dried specimen the green and blue are fairly well preserved but the brown sutural stripes are no longer evident).

Abdominal segment 1 rich brown, apex black, on either side a subapical transverse broad green bar which ends dorsally at the point which marks the inferior termination of the posterior carina; below, the bar curves forward along the ventral margin of the segment and almost reaches the base of the segment; 2 black marked with bright blue as follows: a transverse basal ring, narrow in the middorsal line but widening rapidly on the sides and continuing with the blue on the auricles which are broadly edged with black, a median longitudinal bar, arising in the basal ring and ending posteriorly at the level of the posterior carina, a triangular spot on each

side just anterior to the median carina, and a subapical transverse band on either side (the above description of 1 and 2 applies equally well to the preserved specimen; 2 beneath, anterior to the lateral carina and the auricles largely green, auricles beneath largely black with a broad bar of blue, a dark spot on the margin of the genital fossa opposite and adjacent to the spine of the anterior lamina, margin of the genital fossa, anterior to the point of covergence, very narrowly brown and armed with a single row of seven to nine low scale-like teeth; auricles with eight denticles, the anterior ones very small, increasing in size posteriorly); 3-10 above very dark brown to black; 3 has AL blue, large and shading out above, and MD, PD, ML, and PL green and small; 4 and 5 have AL reduced and the four green spots reduced; 6-8 have AL greatly reduced to a narrow transverse basal line and PL wanting; PD is almost gone on 6 and does not appear on 7 and 8, and on these two segments MD and ML are greatly reduced; on the posterior segments spots MD, PD, and PL are green or bluish green but ML is duller being greenish or bluish yellow; 8-10 and appendages black (all the above markings are more or less discernible in the preserved specimen; beneath the abdomen is brown or yellowish brown).

(Wings hyaline, costa dark, stigma reddish brown, venation black or nearly so; anal loop short and rounded, separated from the anal triangle by two cells; one row of cells throughout between M_2 and Rs in all the wings.)

(Legs entirely black except as follows: first femora broadly green or blue behind for the entire length, and the merest streak of yellow above at the base of the middle tibiae.)

Material examined: a single male, the type, taken near Puerto Berrio, Dept. Antioquia, Colombia, January 31, 1917, by Jesse H. Williamson, for whom this beautiful species is named; specimen in coll. E. B. W. In the account of our collecting trip to Colombia (Univ. of Mich., Mus. of Zool., Misc. Publ. No. 3) on the bottom of page 13 and top of page 14, I have described the forest where this specimen was taken. J. H. W. found it hanging on a vine in the shade in this deep forest. *Jessei* is a close but very distinct relative of *tibiata*. Whether it will be found to have the wide distribution of the latter species remains to be seen. *Tibiata* has not been taken in Colombia but it has been taken in Venezuela in the nearby Catatumbo River basin and there is no reason why these two handsome species may not at some future date be found in the same forest.

Gynacantha auricularis Martin

23 (as *subviridis*), 25, 26.

Abdomen male 50-52, female 51-55; hind wing male 49-51, female 51-54; superior appendage male 5.4, female 4.2-4.8; stigma front wing 4.2-4.8.

The following notes are based on the living colors of the male taken at Palma Sola. Eyes above green, lighter than in *T. ditzleri* and *T. caribbea*, shading out into lighter brighter green in front and below into light greenish yellow with three or four large brown pseudopupillae. Rear of head

pale flesh, narrowly black above, with an irregular black bar to the foramen. Prothorax flesh or very light brown, hind lobe darker. Thorax above green, a narrow interrupted half collar of light yellowish green, bordered above with a brown transverse stripe three or four times as wide which is narrowly continued up the middorsal carina to spots below the antealar sinus; on either side a broad indefinite brown antehumeral stripe which fades out above in the green, and is darker below; mesepimeron light greenish brown, greener above, shading out to brown below; metepisternum and metepimeron pinkish flesh brown, traces of green about the stigma; beneath the same pinkish flesh; sclerites between front wings bright grass green, between hind wings brilliant evanescent blue. Abdominal segment 1 flesh, apical third or half brown above; 2 brown above, a narrow longitudinal median green line which passes posteriorly into a broad blue subapical ring, the extreme apex black; basally a narrow transverse green line on either side, widely separated from the median green line; posterior to mid-length on either side a narrow transverse green stripe or line, narrowly bordered black, and less widely separated than the basal lines from the median line; auricles bright blue above, edged with black (margins of genital fossa without denticles or spines; auricles with seven to nine denticles, with several long black hairs on the dorsal surface near or between the basal teeth); 3 with a large lateral basal blue spot on either side, and traces of pale light brown spots at the transverse carina, base and apex shaded into darker brown; 4 brown, shading into darker at base and apex, a minute green spot on either side at the tranverse carina; 5-7 brown, shading into darker apically and a darker line at the transverse carina; 8 and 9 slightly darker brown; 10 slightly paler than 8 and 9 except at apex; at the transverse carina, on either side of 8 trace of a pale spot.

Female abdominal appendages narrow, of nearly uniform width throughout, about .5 wide, narrowed on the inner margin in the basal seventh, the apical seventh tapering to the acute apex, the tapering mostly on the inner edge, the outer edge being relatively straight throughout the length of the appendage.

Aeschna viridis Rambur was described from a single male with the last seven abdominal segments gone, and "sans indications de patrie." De Selys (Rev. des Od.) stated that it is an exotic species very different from *A. viridis* Eversmann, but there is nothing to indicate that de Selys regarded it as a Gynacantha. The next mention of the species is by Kirby (23) who records specimens from Para and Tapajos, referring them to Gynacantha. At my request these specimens were studied by Mr. Campion who kindly sent me one for study. He reports that there is no reason to think any of these specimens were ever seen by de Selys. The male loaned me by Mr. Campion is *G. auricularis* Martin. If it should be shown that these specimens in the British Museum, or any of them, had been compared with Rambur's type, now lost (Martin, 25), and determined by de Selys as *subviridis,* then *auricularis* would become a synonym. However the description of *subviridis* (*viridis*) seems to exclude this identification and we have in addition Mr. Campion's opinion that de Selys never saw the Para and

Tapajos specimens in the British Museum. The last opinion, that of Ris (36), that *subviridis* is a synonym of *Coryphaeschna luteipennis* is as plausible as any. With the loss of the imperfect type, which lacked a locality label, further discussion of the application of the name is futile.

The only *auricularis* we saw alive came flying down a little creek near Palma Sola at the noon hour, circled once or twice the little pool at the edge of which we were seated eating our lunch, and then alighted on some small tree rootlets on the underside of an overhanging washed out creek bank. Here it was impossible to use a net and the dragonfly was carefully stalked and caught in the fingers.

Material examined: *Costa Rica,* probably Ontario Farm (C. H. Lankester, September 18, 1919, 1 female, A. N. S.); *Venezuela,* Palma Sola, Dept. Falcon (March 6, 1920, 1 male, E. B. W.); *British Guiana,* Bartica (H. S. Parish, May 21, 1901, 1 male, O. S. U.); *French Guiana,* Pied Saut, Oyapok River (S. M. Klages, Nov., 1917, 1 male, Acc. 6111, Carn. Mus.); *Brazil,* Para (C. F. Baker, 1 male, 1 female, U. S. N. M., 1 female, E. B. W.), Val del Can, Para (Hagmann, May 19, 1901, 1 female, Ris), Chapada (Gyn. "t," number 195, 1 male, M. C. Z.), Tapajos (1 male, British Museum, determined by Kirby as *subviridis*).

Gynacantha klagesi, new species

Abdomen male 47-49, female 50; hind wing male 47-48, female 50; superior appendage male 6, female 5.4; stigma front wing 3.6-3.9.

Male.—Labium yellow, greenish at the side; face green, yellowish below and against the eyes, darker above; frons above brown in front for more than half its length with a brown bar to the black frontal vesicle, the pale area on either side of the bar light greenish gray; occiput green or yellowish; rear of head yellowish, narrowly shining black above, with a broad bar of brown or black down to the foramen.

Prothorax light brown, posterior border green.

Thorax bright green above, middorsal carina and margins of the antealar sinus black or brown, the carina narrowly bordered on either side with brown; a short, broad antehumeral stripe or area occupying the outer half and lower two thirds of the mesepisternum, darkest along the anterior edge parallel to the carina, and shading out on all the other edges; sides of thorax bright green, a pale brown line on the humeral suture, a short brown line above on the first lateral and a darker brown line on the second lateral suture. Interalar wing spots green anteriorly and blue posteriorly; spots beneath the front wings green, beneath the hind wings blue and yellowish. Beneath pale flesh.

Abdomen brown to black, the apical segments darkest; 1 brown, L large, yellow, shading into blue above, D apparently not present, extreme apex dark to black; 2 with AML yellow below and blue above, auricles below bright yellow with greenish shadings, above blue, broadly surrounded with dark brown or black, the blue not continuous with AML; AD and MD narrow, green in color, the latter apparently continuous into PD which is joined with PL to form a broad blue transverse bar; transverse carina and

extreme apex black; nine to twelve scale-like teeth in a single row on the posterior half of the converging margins of the genital fossa; eleven to fourteen denticles on the auricles, the most anterior ones the smallest, increasing in size posteriorly, the posterior five or six about equal in size; 3 with AL blue, MD and PD small, apparently green in life, no other spots evident in the preserved specimen; AL and MD small but present on 4-8, ML not quite so plain but fairly distinct traces of it in all of the same segments; 9-10 and appendages dark to black; 3-7 light brown beneath, each segment darker at apex; 8 pale beneath, apparently light green in life.

Wings hyaline, costa dark brown, stigma brown surrounded with darker veins, venation black or nearly so; one row of cells throughout between M_2 and Rs; in the four front wings examined the loop in M_4 is single rowed between M_3 and M_4 in two wings and with a single double cell in the other two wings; in the four hind wings likewise the loop is single rowed in two wings and with a single double cell in the other two wings.

Legs light reddish brown; first femora darker, especially at apex, and with a broad green or gray stripe behind; second and third tibiae yellow dorsally.

Female.—The single specimen is not fully matured and the color is not well preserved. The head is similar to the male. The prothorax and thorax are faded to a uniform unmarked light reddish brown. Abdominal segment 1 brown, darker above posterorly, apically ringed with black; 2 with only MD, PD and PL evident, the first apparently green, the last two clearly blue, but the abdomen is too faded to determine the color pattern certainly; it probably does not differ materially from the male. However AL can be discerned on 3-8, and MD and ML on 3-7; as in the male PD, if present in life, has disappeared due to postmortem changes. The lateral carina on 2 is black and at the level of the transverse carina is elevated in the nearest approach to an auricle attained by the female of any American Gynacantha. The ventral carina on the same segment is also characteristically curved at its posterior end in a manner suggesting the form in the male. At the anterior end of the ventral carina and just above it is a brown spot.

The abdominal appendages are linear to about five-ninths the length, where they widen slightly in a symmetrical expansion which tapers symmetrically to a rather abruptly acute apex; the expanded portion with a maximum width of about .5 and with a low median dorsal longitudinal keel.

Wings similar to the male, stigma paler, due doubtless to less mature condition; one row of cells throughout between M_2 and Rs; in both front wings and one hind wing the loop in M_4 is single rowed between M_3 and M_4, and in the other hind wing there is one double cell and one forked cell. Legs as in the male.

Material examined, *French Guiana,* Tamanoir, Mana River (S. M. Klages, May and June, 1917, 2 males, 1 female, Acc. 6008, Carn. Mus., type male, June and allotype female, May). This fine species is named for S. M. Klages, whose collections have added much to our knowledge of neotropical insects.

Gynacantha ercagris Gundlach

11.

Abdomen male 43-44.5, female 45-46; hind wing male 42-43, female 43-46; superior appendage male 6; stigma front wing 3.5-4.

The above data is from Calvert. I have seen no additional specimens and have nothing to add to his discussion of this species. It has been taken only in Cuba and the Bahamas.

Gynacantha mexicana Selys

6, 10, 25, 26.

Abdomen male 49-52, female 49-51; hind wing male 46-48, female 47-50; superior appendage male 6-6.6, female 7.5-9; stigma front wing 4.6-5.1.

Wings hyaline to brown tinged, slightly to distinctly brown at base between C and R+M, darker between Sc and R+M, as far as or slightly beyond the first antenodal; more or less distinctly yellowish between Sc and R+M to the nodus, and between C and R beyond the nodus; this longitudinal stripe usually most evident in wings otherwise hyaline, but even in some hyaline wings no trace of it exists.

In the male there are nine to fifteen scale-like teeth in a row on the ventral carina of segment 2 anterior to the convergence of the margins of the fossa, and teeth are absent or there may be as many as five on the prominence, near the apex of the segment, where the lateral and ventral carinae meet. There are four or five denticles on each auricle. The abdominal appendages of the female have the outer edge relatively straightened and the inner curved, the widest point slightly distal to the middle, so the basal half of the appendage is more tapering than the apical half; a very faint longitudinal median dorsal carina; maximum width 1.5; extreme apex acute. The appendage is thus distinctly different from such other species as *nervosa* and *interioris*.

The following notes on living colors were made from specimens collected at Bejuma and Palma Sola. Male.—Eyes above dark brown (or dark green), almost black, with a small (or large) green reflecting area in front on either side, which green area may be wanting in the female; below light brown (with a slight yellowish cast), with one large black and about five dark brown pseudopupillae; rear of head pale dull yellow, narrowly black above, with a broad band of black to the foramen.

Prothorax light flesh brown, middle lobe with a bluish cast. Thorax above bright (or dull) olive green, clouded with brown; a narrow rich brown mesothoracic half collar which is bordered below by a slightly narrower, narrowly interrupted, bright yellowish green half collar; above the brown half collar the thoracic green is brightest and clearest, and on its outer edges are traces, more or less, of a dorsal brown stripe which is definite only opposite and immediately adjacent to the green; mesepimeron above green, below brown; metepisternum brown, restricted green above; metepimeron

brown, a trace of yellow at the extreme upper edge; four spots on the side and a latero-ventral stripe black; sclerites between wings bright blue (or those between front wings green).

Abdomen reddish brown, 1 paler with an apical narrow transverse blue bar, bordered very narrowly behind with black; 2 with a similar wider blue bar (PD) and narrow green MDs, black bordered behind, reaching or not to the auricles which are brown, edged with black; 3 with AL small, blue; 3-8 with MD and PD present and small, green in color, smaller and paler progressively posteriorly, PD on 7 and MD and PD on 8 yellowish, 9 with PD only; 3-8 and 10 each with extreme apex black ringed; 3-7 each narrowly black edged on the lower lateral margin, PL more or less distinctly present.

Female similar, only slightly duller, thorax above lighter, and AL, MD and PD on 3-7 light dull yellow (probably green in some cases).

In flight and environment this species so far as I have observed resembles *G. nervosa* though it is possibly more wary and slightly more erratic. At Georgetown I took a single female flying alone at twilight in the Botanical Gardens. At Bolivar it was flying at twilight with other species. At Palma Sola it flew along the railroad tracks in the evening with *G. nervosa*. Between the northeastern part of the town of Bejuma and the river, so called, lying to the north are a number of artificial depressions, some with shallow pools of water, formed by excavations for clay. There is no adjacent native forest, but there are scattered low bushes, and, at short distances, some trees along the river and in nearby coffee plantings. The mud about the pools is irregularly roughened by the sharp hoofs of visiting burros, and in their deep tracks we found the females of *mexicana* ovipositing. Yellow breasted flycatchers, resembling kiskeedees, at dusk from nearby bushes watched the pools for the dragonflies. No attempts were made by the birds to capture the swift flying males but when a female alighted and descended into one of the burro tracks there was usually an observant bird ready to take advantage of her helpless position. Alighting over the depression the bird seized the dragonfly at her work several inches below the surface. No other species of Gynacantha was found at these clay diggings. Along the grade for the railroad Y at Fundacion are a number of shallow, muddy pools formed by excavations for the railroad grade. Here we found *mexicana* flying at dusk, coming from over the adjacent pastures to patrol the pools, returning again to the wider range of pastures.

Material examined: *Colombia,* Bolivar, near Santa Marta (December 21 and 24, 1916, 3 females, E. B. W.), Fundacion, Dept. Magdalena (January 9 and 10, 1917, 2 males, 1 female, E. B. W.), *Ecuador,* San Rafael (F. Campos R., 1 male, 1 female, A. N. S.), Babahoyo (F. Campos R., 1 male, A. N. S.); *Venezuela,* Palma Sola, Dept. Falcon (March 7-10, 1920, 5 males, 3 females, E. B. W.), Bejuma, Dept. Carabobo (February 12-23, 1920, 7 males, 5 females, E. B. W.), El Guayabo, Dept. Zulia (April 20, 1920, 1 female, E. B. W.); *British Guiana,* Georgetown (February 18, 1912, 1 female, E. B. W.); *Brazil,* Para (C. F. Baker, 1 male, E. B. W.).

Gynacantha nervosa Rambur

6, 7, 11, 12, 19, 20, 23, 25, 26, 31, 35, 36.

Abdomen male 50-54, female 52.5-57; hind wing male 47-54, female 52.5-56; superior appendage male 6.5-7.5, female 5.4-6.3; stigma front wing 4.5-5.7.

Wings hyaline to brown tinged; in some cases, and this seems especially true of tenerals or younger individuals, irrespective of locality, there is a faint yellowish longitudinal stripe, which suggests the wing coloration of *bifida*, but in such specimens of *nervosa* the yellow line is not darkened and more conspicuous basally as it is in *bifida*.

The margins of the genital fossa of segment 2 in the male are armed on each side, anterior to the point of convergence, with eleven to nineteen scale-like denticles, mostly in a single row, about twelve being the most usual number; and the auricles are armed with five to eight denticles, five or six being the usual number. The female abdominal appendages are linear at the base, the apical third or more slightly widened, suggesting in a way a modified male appendage of this group; the expanded portion with a dorsal median longitudinal carina or low keel; maximum width .6; extreme apex acute.

Dr. Calvert has kindly furnished me with notes on living colors of two Costa Rican males. Where these descriptions are not in accord the differences shown are indicated in parentheses. Eyes olive green above, very pale brown below (dark brown above, bordered anteriorly with a line of pale green, below which the eye is pale brown) with distinct black pseudopupillae; face and lips very pale brown; frons superiorly pale green with a black T-spot; vertex black with a pair of very small greenish spots; occiput pale bright green; rear of head very pale green, eye margins black. Dorsum of thorax pale green, sides with some green but mostly (also pectus and legs) pale brown (most of sides of thorax and pectus very pale lilaceous). Dorsum of abdomen dark brown with small (pale) green dorsal spots (or transverse lines) as follows: a dorsal apical transverse green stripe on 1; a middorsal longitudinal green line on 2; three transverse stripes, all interrupted middorsally, at anterior end, middle, and posterior end of 2; 3-8 similar to 2, lacking the longitudinal green stripe, but the transverse stripes mere lines, the middle stripe at the transverse suture (the apical spots or interrupted stripes absent or almost so on 7 and 8); 9 with (without) apical spots; 9 and 10 with (without) traces of the anterior spots; ventral surface of abdomen pale lilaceous (probably usually brown, E. B. W.), a pale brown longitudinal stripe on ventral part of each tergite of 2-8.

The following notes were made on living colors of specimens taken at Palma Sola. Male.—Eyes above dark green, a blue transverse line in front on either side, shading below into pale yellowish brown with six to eight or more brown pseudopupillae; rear of head narrowly black above, remainder light dull yellow. Prothorax flesh colored, middle lobe brown. Thorax above with a very narrow light yellow mesothoracic collar, this collar bordered above and below with light reddish brown, dorsum green, rather dull, indefinite antehumeral brown areas fading out above; mesepimeron and

metepisternum brown, greenish above, metepimeron paler; sides of thorax with small distinct brown or black spots; beneath light flesh brown, whitish; interalar spots green. Abdomen brown; 1 pale at base with a brown basal spot above on either side and a narrow subapical bluish green transverse band, the extreme apex black; 2 with a widely interrupted narrow transverse basal green band, a less interrupted oblique green band at the transverse carina, which carina is black, a wider uninterrupted but narrowed, subapical blue band, the extreme apex black, and a narrow longitudinal median green stripe which posteriorly passes into the apical blue; (J. H. Williamson noted on a Palmdale, Florida, male: spots between wings and on basal abdominal segments, green); auricles above bluish gray, edged black; 3-8 each with a very small basal spot on either side, minute on 7 and 8; 3-9 each with a small triangular spot on each side at the transverse carina, these spots basal on 9; 3-8 and 10 narrowly black at apex, 10 with a small basal median spot; lower lateral margins of 3-9 pale, this pale area interrupted on each segment at the tranverse carina and by a downward projection of the dorsal brown between the transverse carina and the apex, thus dividing the pale lateral area of each segment into three areas or spots, the posterior one of these areas becomes progressively smaller posteriorly and wanting on 6 and posterior to that segment. Female.—Similar to male but duller; lower lateral edge of abdomen paler, the posterior one of the three pale areas on each segment present on 3-7, and the sides below of 8-10 largely pale.

The following less detailed notes were made from slightly teneral males taken at Santa Marta: eyes above and thorax above greenish brown; narrow obscure short brown thoracic stripes on mid-mesepisternum; thorax below and behind brown; wing bases and markings on 1 and 2 blue. Abdomen clove brown, markings black and light dull yellow. And of an adult male taken at Bolivar I have the following note: thoracic dorsum greenish brown, sides light brown; abdomen darker brown; 1 and 2 marked blue, other segments marked black and yellowish.

G. nervosa seems essentially crepuscular in its flight. Where the species occurs abundantly the numbers on the wing and in sight at once, the mobile active flight, and the rapidly coming darkness of the tropical night combine to form a scene to fire the imagination. The collector has spent the day in the forest closely surrounding the little village of thatched huts which he knows as "home," and among the hundreds of dragonflies flying about woodland pools and streams no *nervosa* have been seen. At sundown, muddy, wet and tired he returns home. Suddenly a large brown dragonfly goes with undulating flight down the village path before him. In a bit of near-by garden another with lower more direct flight appears. Then three or four are seen circling about a thatched hut and at once the garden and path are alive with interweaving forms and the flight is on. They come from everywhere, the air is filled with them, some fly erratically, others patrol regular beats, apparent spots of greater density lure the collector from one point to another. As suddenly as they appeared, only a few are seen, and then they are gone, and the disappointed collector with possibly only two or three specimens in his bottle, realizes that the twenty to thirty

minute flight is at its end, and that he will not see *nervosa* again for twenty-four hours.

That the flight is not always confined to the evening however is shown by a note by Klages at Cayenne, French Guiana: "Flies at dusk and at dawn only; captured in mangrove swamp." Neither is the flight confined to villages, but so far as I have observed numbers are found only about clearings or extensive open places, and it is probable that in such places, in proximity to houses, cattle, grasses and freshly hewed timbers, *nervosa* finds its most abundant food supply. Abundance of food supply may be a factor in determining the number of flights in each twenty-four hour period or the amount of activity during the day. The number of specimens recorded below from Cayenne, where two flights a day were observed, and from Palma Sola, where there was a single flight, may possibly indicate a difference in abundance of *nervosa* on the wing and a difference in the abundance of the food supply. In dark places in the forest with presumably different insect prey one might expect to find *nervosa* on the wing throughout the day and our observations seem to bear this out. In the forests about Palma Sola, where most wonderful evening flights occurred, the four of us, ranging the forest every day, never saw a *nervosa* till the evening flight began. At Puerto Berrio, where we did not see *nervosa* about the town, we took a single male at 9 A. M. one day flying in brush in dark forest about five kilometers from town. J. H. W. noted at Palmdale, Florida: *nervosa* found in darkest part of cypress grove in creek bottom, flying about bases of trees, or hanging up from three to five feet above the ground. As might be expected from its habits at certain times and places of flying closely about buildings, *nervosa* occasionally and apparently accidentally, enters such buildings and is rarely entrapped and captured there.

At Cristalina, Colombia, about noon one day I saw a Gynacantha fly out from some brush far ahead of me along the creek. It fluttered along in a helpless manner and in attempting to return to the brush, fell into the water from which I picked it. It was a male of *G. nervosa* and on the dorsum of abdominal segments 2 and 3 were six small white eggs. This specimen was sent to Miss Currie at Washington, and the eggs were identified as those of some diptera, apparently a tachinid. There is no previous record of tachinids being parasitic on dragonflies. The same day another *nervosa*, apparently ill also, was seen fluttering through the brush with hanging abdomen, but I lost sight of it and did not capture it. A male, also taken at Cristalina, had in its mouth an insect identified by Mr. McAtee as a cicadellid.

I have observed *nervosa* ovipositing on two occasions. At Maraquita, Colombia, at the edge of town there was a much used water tap, the overflow water being drained in an artificial ditch with steep dirt sides. About 6 P. M. several females were observed ovipositing in the soil on the banks of this ditch. In Trinidad a female was taken about noon ovipositing in the damp but hard earth of a wet-weather stream bed in low forest. Staurophlebia in larger numbers were ovipositing at the same place.

Material examined: *California* (1 female, A. N. S.); *Florida* (W. H. Finn, Coll. C. V. Riley, 1 male, U. S. N. M.), (1 female, A. N. S.), Paradise Key, Everglades of Dade Co. (C. A. Mosier, November, 1917, 1

male, U. S. N. M.; shot in dense hammock 18 miles S. W. of Paradise Key, H. S. Barber, March 11, 1917, 1 female, U. S. N. M.), South Jacksonville (W. T. Davis, November 3, 1911, 2 females, W. T. D.), Lakeland (W. T. Davis, November 8, 1911, 2 females, W. T. D.), Punta Gorda (W. T. Davis, November 15, 1911, 1 female, W. T. D.), Gulfport (G. A. Reynolds, June, 1914, 1 male, Ris), Palmdale (J. H. Williamson, April 5, 1921, 3 males, 1 female, E. B. W.), St. Petersburg (Mrs. Chas. C. Deam, October 6, 1907, 1 male, E. B. W.), Miami (S. N. and M. C. Rhoads, January 16-24, 1899, 3 males, 2 females, E. B. W.); *Guatemala,* Santa Lucia (February 1, 1905, 1 male, 1 female, E. B. W.); *Costa Rica,* Liberia (J. F. Tristan, room in schoolhouse, January 12, 1910, 1 male, A. N. S.), Caché (C. H. Lankaster, caught in office, March 19, 1910, 1 female, A. N. S.); *Canal Zone,* camp at Empire (Lieut. G. C. Dunham, 1917, 1 female, U. S. N. M.); *Colombia,* Puerto Colombia, Dept. Bolivar (December 11, 1916, 1 male, E. B. W.), Santa Marta, Dept. Magdalena (December 13-16, 1916, 4 males, E. B. W.), Bolivar, near Santa Marta, (December 21-26, 1916, 2 males, 4 females, E. B. W.), Don Diego, 100 ft., and Bonda, 250 feet, Dept. Magdalena (H. H. Smith, 1 male, 2 females, Carn. Mus.), Rio Frio, Dept. Magdalena (January 7, 1917, 1 female, E. B. W.), Fundacion, Dept. Magdalena (Jan. 9 and 13, 1917, 1 male, 1 female, E. B. W.), Puerto Berrio, Dept. Antioquia (February 21, 1917, 1 male, E. B. W.), Cristalina, Dept. Antioquia (February 11-20, 1917, 20 males, 9 females, E. B. W.), Maraquita, Dept. Tolima (February 4 and 5, 1917, 2 females, E. B. W.); *Ecuador,* Babahoyo (F. Campos R., 1 male, 3 females, A. N. S.), Guayaquil (F. Campos R., 4 males, 2 females, A. N. S., 2 males, 1 female, Ris); *Bolivia,* Province del Sara, Dept. Santa Cruz, 350-450 meters (José Steinbach, 1 male, 3 females, Accs. 5076, 5574 and 6443, Carn. Mus.); Puerto Suarez (José Steinbach, November, 1908-January, 1909, 1 female, Acc. 3842, Carn. Mus.); *Venezuela* (Appun, 1 male, M. C. Z.), Palma Sola, Dept. Falcon (March 4-10, 1920, 4 males, 13 females, E. B. W.), La Fria, Dept. Tachira (April 12-16, 1920, 7 males, 4 females, E. B. W.), Tachira, Dept. Tachira (April 10, 1920, 1 female, E. B. W.); *British Guiana,* Rockstone (February 1, 1912, 1 female, E. B. W.); *Dutch Guiana,* Paramaraibo (K. Mayo, 1 male, A. N. S.); *French Guiana,* Cayenne (S. M. Klages, March, 1917, 3 males, Acc. 5897, Carn. Mus.), Tamanoir, Mana River (S. M. Klages, May, 1917, 2 males, Acc. 6008, Carn. Mus.); *Brazil,* (1 female labelled "Mus. Berol," and "robusta," M. C. Z.), Chapada (1 male, M. C. Z.), Cachoeira (1 female, M. C. Z.); *Trinidad,* Baracon, Chaquanas (March 7, 1912, 1 female, E. B. W.); *Cuba* (Poey, 1 female, M. C. Z.), S. Diego d. l. Banos (Palmer and Riley, April, 1 male, U. S. N. M.); *Hayti,* Samana (Frazar, 1 male, M. C. Z.); *Jamaica* (C. W. Johnson, 1 female, A. N. S.).

Gynacantha bifida Rambur

5, 6, 25, 26, 31, 33, 35, 36, 39.

Abdomen male 51-52, female 53-54; hind wing male 51-52, female 54-55; superior appendages male 7.2, female 6; stigma front wing 5.1-5.7.

In the male there are eleven to thirteen scale-like teeth in a single row on each side of the converging margins of the genital fossa of the second

abdominal segment. The auricles are armed with five to seven denticles. The female abdominal appendages are narrow, slightly widening on the inner edge from the base to about two-thirds the length where the maximum width is about .6; the median keel on the apical third low and inconspicuous; apical third tapering symmetrically to the apex, with the extreme apex acute.

Dr. Ris (35) has studied this species carefully and places *G. robusta* Kolbe as a synonym.

Material examined: *Brazil* (through Scheider, Berlin, 1 female, Ris), Minas Geraes (Rolle, 1914, 1 female, Ris), Bom Jesus de Itabapoana, Rio Janeiro (Zikàn, January 21, 1905, 1 female, Ris), Salto Grande, Rio Paranópanéma, Sao Paulo (J. D. Haseman, October 21, 1908, 1 male, Acc. 3202, Carn. Mus.), Porto Catherina de Santa Leopoldina (2 males, E. B. W.); *Argentina*, Yuto, Jujuy, 450 meters (Joergensen, April, 1911, 1 male, Ris).

Gynacantha croceipennis Martin

5, 24, 25, 26, 36.

Abdomen male 55, female 60; hind wing male 54, female 57; superior appendage male 7; stigma front wing 6.

I have seen only the material from Peru and Bolivia in Dr. Ris' collection, carefully studied by him (36). The young female from Pozuzo is the only Peruvian specimen; it is smaller than the others, abdomen 55 and hind wing 55 (not 52, as stated). Teneral specimens of *bifida* sometimes show some yellowing of the wings and it is not impossible that large series of *bifida* would show that species to be as variable as *nervosa* is known to be in this character. The same thing may be true of all the *nervosa* group, including *interioris* to which species I am inclined to refer this Pozuzo female, though I have seen no other specimens referred to that species as darkly tinged as the Pozuzo female. The specific distinctness of *croceipennis* is open to serious question. In the males, wing color, a dubious character in this connection, alone separates it from *bifida;* and in the females the same unreliable character alone separates it from *bifida* and *interioris*. At the same time but little material is known and better characters may be discovered later. Because of its geographical range and the greater elevation at which it occurs as compared with *bifida*, the name should stand for the present, though it is not improbable that a condition analagous to that found in certain species of Hetaerina is duplicated here, for we know some Hetaerinas of wide range, which, in the mountains, attain a size and a depth and extent of wing coloration unrivalled by the same species in lower situations.

Gynacantha litoralis, new species

Abdomen male 50; hind wing male 48; superior appendage male 6.6; stigma front wing male 4.8.

Male.—Labium and face pale yellowish brown; frons and frontal vesicle black, a pale brown median transverse bar on either side of the frons, wider than in *interioris*, and with its fellow of the opposite side defining a con-

spicuous T-spot; occiput yellow or greenish yellow; rear of head as in *interioris*.

Prothorax and thorax as in *interioris*.

Abdomen faded, apparently similar to that of *interioris* but darker, so the lateral carinae on 4-7 are not conspicuously darker than surrounding areas; the four lateral brown spots on 2, described in *interioris*, not as distinct as in that species; auricles each with six denticles; about ten scale-like teeth in a single row on each side of the genital fossa anterior to the point of convergence; PL apparently wanting on 5-7 and other lateral spots apparently reduced on these segments, but these details cannot be certainly determined from the dried specimen. Appendages brown.

Wings slightly clouded at the extreme base, costa and stigma light yellowish brown, the end and posterior veins of the latter darker; venation generally a light reddish brown, giving the wing a ruddy apearance at certain angles.

Legs similar to those of *interioris*, the tarsi less darkened apically.

The following notes were made on the recently captured male: Eyes above dark green, blue across the middle at the level of the frons, below drab. Dorsum of thorax pale green over a limited area, shading out above and laterally, sides dark flesh or light brown with shadings of green beneath the wings; spots between front wings green, between hind wings blue. Abdomen dark brown, nearly black, 1 and 2 paler, (sub) apical blue rings on 1 and 2 and an interrupted basal blue ring on 3; dull drab lateral spots on 3-9; beneath pale brown, darkest on 4-6. Flying at twilight along a dry ditch near the botanical gardens.

Dr. Calvert has seen the single male and in his opinion it represents an undescribed species. He compared it with *ereagris* which has simpler venation and superior appendages less widened apically.

Material examined: *Dutch Guiana*, Paramaribo (February 22, 1912, a single male, the type, E. B. W.).

With some question I have referred also to this species two males and two females from Manaos, Brazil, collected by Miss H. B. Merrill, and in the U. S. N. Mus. One of these specimens bears the following note: Lake near Manaos, Santa Maria, February 22, 1908; first three segments of abdomen with spots of sky blue; eyes blue; sides of thorax green and brown; abdomen brown.

In general appearance these four specimens are strikingly different from the type from Paramaribo, but I have found it impossible, with the limited material, to satisfactorily separate them. The Brazilian specimens are larger; abdomen male 53, female 56; hind wing male 52, female 55; superior appendages male 6.7; stigma front wing 5.4-5.6; and the wing venation is much more complex. For example, in addition to characters indicated in the tabulation of venational characters, in the Brazilian specimens there are two rows of cells between M_2 and Rs adjacent to the forking of Rs; in the type there is one row of cells throughout between M_2 and Rs. In the Brazilian specimens, moreover, the wings of all are uniformly brown-tinged throughout and the veins are dark colored. To this character and to the larger size are due the striking dissimilarity in general apearance of the

specimens from the two localities. At the same time the differences in complexity of venation, the coloring of the wings and the size offer no specific characters and I have been unable to detect others.

Gynacantha interioris, new species

Abdomen male 54-56, female 54-57; hind wing male 51-52, female 54-56; superior appendage male 7.2-8.1, female 7.5; stigma front wing 5.4-6.3.

Male and female.—Labium and face pale yellowish brown; more or less darker above; frons above and frontal vesicle black, a pale brown median transverse bar on either side of the frons which thus, with its fellow of the opposite side, defines a large conspicuous T-spot; occiput greenish yellow; rear of head light brown or yellowish brown, above narrowly shining black adjacent to the eyes with a brown or black bar to the foramen.

Prothorax light brown, the middle and hind lobes indefinitely shaded with brown, the front lobe almost white.

Thorax brown, darker to almost black with or without greenish reflections on the middorsum; metastigma surrounded with black, a small brown spot above it, another brown spot on the mesepimeron at the upper end of the second lateral suture, and a more or less distinct spot posteriorly on the latero-ventral carina.

Abdomen brown; 1 with a subapical dorsal transverse blue bar, bordered behind and below with black; 2 with AD the length of the segment, and MD and PD present, apparently all blue in life, sides obscure brown, bright colors not evident in dried material, in the male a brown spot just above the auricle near its middle, a round spot posterior to this a distance slightly more than the diameter of the anterior spot, a brown area below this posterior spot in the angle of the auricle, and a brown spot near the ventro-anterior margin of the segment; auricle blue above, black edged, armed with five to eight denticles; the ventral margin of the genital fossa, anterior to the point of convergence, armed with a single row of eleven to thirteen scale-like teeth; 1-8 narrowly black ringed at apex; 3-8 with MD and probably ML present on all, and 3-7 apparently with AL, ML and PL present on each, ML especially large and distinct; in life these spots are probably greenish yellow or, in the case of the lateral spots, yellowish; lateral carina black on 4-7; appendages brown or black. Appendages of female, narrow at base, slightly more than the apical half expanded, suggesting a modified male appendage of this group, expanded portion with a dorsal median longitudinal carina or low keel; maximum width .8-.9; apex tapering, acute.

Wings hyaline to brownish tinged, with a longitudinal dark stripe, especially conspicuous in the hyaline wings. Costa light yellowish brown; the stigma the same color, darker above, the enclosing end and posterior veins black; venation black or nearly so.

First femur dark brown, shading to black at apex, a broad pale stripe behind; second and third femora pale reddish yellow; tibiae and tarsi pale yellow, paler than the second and third femora, the tarsi dark to black at the apex adjacent to the dark reddish brown tarsal claws.

J. H. W. noted of the male taken by himself on June 6 at Campamiento, Colonia del Perené, elevation 680 meters: Twilight flier at the crossing of the trail and Quebrada Repressa, 5:50 P. M., rare and difficult to catch. The female we took at Tachira, elevation 364 meters, was flying erratically along the railroad track when it was nearly dark.

Material examined: *Venezuela,* Tachira, Dept. Tachira (April 10, 1920, 1 female, E. B. W.); *Peru,* Campamiento, Colonia del Perené (J. H. Williamson, June 4-6, 1920, 3 males, 1 female, E. B. W.), San Ramon (J. C. Bradley, June 16, 1920, 1 female, Cornell), Yurimaguas (H. S. Parish, April 3, 1920, 1 female, E. B. W.); *Brazil,* Santarem (S. M. Klages, May, 1919, 1 female, Acc. 6324, Carn. Mus.). Type male and allotype female, Campamiento, Peru, June 5 and June 4, 1920, respectively, E. B. W. For a possible additional record see text under *croceipennis.*

Gynacantha gracilis Burmeister

3, 6, 8, 9, 10, 11, 20, 25, 26, 38.

Abdomen male 60-62, female 58-62; hind wing male 57-62, female 57-63; superior appendage male 6.4-8.2, female 8.2-9.4; stigma front wing 5-6.2.

Female appendages with the outer edge relatively straight, inner edge widening from the slender base to about two-thirds the length of the appendage where the maximum width is about 1 or 1.1, from which it tapers gradually to the acute apex; a low median dorsal longitudinal carina is more or less evident.

The following notes on living colors were kindly given me by Dr. Calvert: Male, forest near highest reservoir, upper Banana River, Costa Rica, November 9. Eyes ranging from blue above through green adjoining the genae, yellow to reddish brown along the postero-inferior margin. Frons brown with a superior black spot; nasus olive; labrum and external surface of mandibles yellowish; labium pale brownish green. Thorax chiefly grass green with an ill-defined brown antehumeral stripe, a narrow brown stripe on the second lateral suture, and a superior brown stripe on the metepisternum; pectus pale brown. Abdominal segment 1 luteous with a posterior dorsal blackish spot; 2 dark reddish brown, a middorsal line, a transverse median line and a posterior transverse stripe blue, and all interrupted; auricles blue above, black margined; 3-10 dark brown, almost black; 3 flesh colored laterally on the basal two-thirds, with a basal blue spot on each side; a fainter blue spot just posterior to the median transverse carina on each side of 3-8, becoming fainter on each successive segment; ventral surfaces of 3-10 pale reddish brown with a trace of blue near the middle of each. Legs dark red, knees and tarsi black.

Material examined: No locality (Mus. Berol., 1 female, M. C. Z.); *Costa Rica,* probably Ontario Farm (C. H. Lankester, September 15 and 18, 1919, 1 male, 1 female, A. N. S.); *Ecuador,* Quevedo (F. Campos R., 1 female, A. N. S.); *Bolivia,* Rio Yapani, 650 m., Dept. Santa Cruz (José Steinbach, 1914-1915, 1 female, Acc. 5574, Carn. Mus.); *Venezuela,* La Fria, Dept. Tachira (H. B. Baker, April 12, 1920, 1 male, E. B. W.); *British Guiana,* Kartabo, Bartica Dist. (W. T. M. Forbes, October, 1920,

2 males, one "in shady path," Cornell); *Dutch Guiana* (Mus. Berol., 1 male, M. C. Z.); *Brazil*, Tapajos, Mte. Christo and Barreiras (A. H. Fassl, May, 1920, 3 males, Ris), Rio Janiero, Bom Jesus de Itabapoana (Zikàn, November 23, 1904, 1 female, Ris).

Gynacantha membranalis Karsch

6, 9, 20, 21, 25, 26, 27, 30 (as *jubilaris*), 36, 37.

Abdomen male 55-63, female 61.5-65; hind wing male 55-60, female 59-64; superior appendage male 6-6.5, female 6.9-7.2; stigma front wing 5.5-6.6.

The auricle in the male has only three, more rarely four, denticles, and between the two posterior (basal) teeth and on the dorsal surface of the auricle are a number of long black hairs. Superior appendage of female narrow, the outer edge nearly straight, widening very gradually on the inner edge from the base to beyond the middle where the maximum width is about .9; from this point tapering gradually in the apical third to the acute apex; a low dorsal median longitudinal keel usually about half as long as the appendage itself and with its extremities about equally distant from the base and the apex of the appendages or more extended on the apex.

Among the females, and especially among the more recently emerged of these, are individuals with the costal area of the wing colored dark brown, the color continuous basally with the usual basal colored area; this brown longitudinal stripe is bounded posteriorly before the nodus by R and after the nodus by M_1. Between females with this region darkly marked and females with the same area hyaline, all degrees of coloring exist.

Of the Guacimo, Costa Rica, male, Dr. Calvert noted: "Eyes in life brilliant metallic green." The single male from Rockstone, British Guiana, may owe its dark color to its recently emerged condition, though the blue color on segment 2 was bright and clear. My brief notes made on this specimen are: Eyes and thorax above black, sides of thorax black and light brown; abdomen above black; sides of 3-6, below the transverse carina, pale; 2 with the auricles and spot above bright clear blue. The thorax of this specimen showed no trace of green which was the dominant color in the Venezuelan specimens described below, and the dorsum especially was a deep velvety black. The specimen is fresh, but apparently mature; equally recently emerged specimens from Venezuela are green, and I believe the difference is racial rather than individual. The following notes were made from a San Esteban male: Eyes dark green, almost black above, gray below. Prothorax brown with a short transverse green bar near the posterior border. Mesepisternum brilliant green with a black bar, giving the effect of two dorsal green stripes on either side of the dorsum; black bar darkest below, shading out above; mesepimeron slightly but very little duller than the mesepisternum; a black bar on the second lateral suture, shading out over the metepimeron to brown, with the upper and posterior edges of the sclerite green. Segment 1 largely green, dorsum apically brown; 2 black, auricles above, a narrow transverse basal line on either side, a narrow longitudinal middorsal line, and a large transverse subapical spot

on either side, bright blue; sides of 3 below from base to slightly posterior to the transverse carina duller blue; 3-5 each with a small triangular blue or green dorsal spot on either side at the transverse carina, the two spots on each segment very narrowly separated; otherwise the abdomen above and on the sides is dark brown or black. Femora rich reddish brown, black at apices.

The following notes were made from a San Esteban female: Eyes very dark brown above, gray beneath. Mesothorax and metepisternum green, the last gray behind along the suture; dorsum of thorax darker green with a black bar on each side and black on the middorsal carina and bordering the antealar sinus in front; metepimeron black, gray behind and below; black between the front wings, posteriorly blue spotted between the wings. Segment 1 light brown, dark above apically; 2 largely black above with a blue subapical spot on either side and traces of a longitudinal middorsal stripe; 3-6 with a small spot on either side at the tranverse carina, these spots progressively smaller posteriorly, and the spots on each segment very narrowly separated.

Membranalis is a wide ranging and adaptable species. In Venezuela, after collecting it on the high rocky quebradas back of San Esteban, associated with such things as Hetaerina, Cora, and Heteragrion, we were surprised to find it equally at home about the small scattered muddy spots in the heavy low-lying forests about La Fria, where its dragonfly associates were such things as Lestes, Metaleptobasis, and Orthemis. The San Esteban specimens were all freshly emerged, and their recent advent into aerial life may account for the frequently observed high soaring, back and forth over some quebrada, which opened a path through the forest for their flight.

On February 5 at 4 P.M. several were seen soaring high above the reach of an insect net and an effort was made to bring them down with our revolvers loaded with dust shot. We crippled two, but they darted downward into the forest and we could not find them. The next day J. H. W. at the same place, flushed a specimen, which he easily caught, and which proved, by the shot marks, to have been one of our targets of the day before. On February 9, we observed that *membranalis* was on the wing at all times from about 9 A. M., when we reached the quebrada above Las Quiggas where we spent the day, till 4 P. M. when we left. About 3:30 P. M. possibly eight or ten were patrolling a stretch of quebrada about two hundred feet long where an extensive land slide had opened the stream to the sun. Five of these were captured, one male and four females, and all were recently emerged. On several occasions we observed males, apparently in search of females, flying about rocky pools of crystal water high up the quebradas back of San Esteban. And at La Fria a male taken near a pool of the consistency of batter or gravy, lying in a great expanse of level forest, had parts of the abdomen and wings coated with a wash of light reddish earth, probably due to an attack on an ovipositing female. The male taken at Rockstone, British Guiana, was captured just after sundown patrolling a stagnant pool in a mud-bottomed creek in which the water

had ceased to flow. At this stream and nowhere else have we found *membranalis* and Staurophlebia associated.

As Ris (36) points out, *G. jubilaris* Navas is a synonym of *membranalis*.

Material examined: *Costa Rica,* Guacimo (in forest, P. P. Calvert, June 6, 1909, 1 male, A. N. S.), Alajuela (D. E. Harrower, August 2, 1915, 1 male, A. N. S.); *Panama* (Hassler, 1 male, M. C. Z.); *Colombia* (Appun, 1 female, M. C. Z.), Sta. Fe de Bogota (Lindig, 1 male, M. C. Z.), Rio Negro, East Colombia (A. H. Fassel, 1911, 1 male, 800 m., 1 female, 500 m., Ris); *Bolivia,* Prov. del Sara, 450 m. (J. Steinbach, 1 female, Acc. 4547, Carn. Mus.); *Peru,* Iquitos (1 female, M. C. Z.; W. T. M. Forbes, August 4, 1920, 1 male, Cornell); *Venezuela* (Appun, 1 male, M. C. Z.), San Esteban, Dept. Carabobo (February 1, 6, 8 and 9, 1920, 3 males, 9 females, E. B. W.), La Fria, Dept. Tachira, 140 m. (April 12, 13, 15, 18 and 21, 1920, 3 males, 1 female, and 1 male and 3 females by H. B. Baker, E. B. W.); *British Guiana* (1 male, Cornell), Bartica (H. S. Parish, May 15, 1901, 1 male, O. S. U.), Rockstone, (February 2, 1912, 1 male, E. B. W.); *French Guiana,* Tamanoir, Mana River (S. M. Klages, May, 1917, 2 males, 1 female, Acc. 6008, Carn. Mus.); *Brazil* Benevides, Para (S. M. Klages, October, 1918, 1 male, 1 female, Acc. 6174, Carn. Mus.).

Note

In the U. S. N. M. is a male Gynacantha labelled Crowley, Louisiana, July 17, 1911, E. S. Tucker, collector. This is very close, if not identical to the widely distributed oriental *G. hyalina.* Miss Currie feels certain the locality label is correct. Mr. Tucker has no recollection of the specimen. If it was really taken in Louisiana it is probable it was brought to this country as an egg or larva and it is improbable that an undescribed Gynacantha inhabits Louisiana.

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Tabulation of Venational Characters

The tabulation of venational characters based on the following males: *Triacanthagyna septima,* 5; Puerto Barrios, Guatemala, 1; Rio Frio and Bolivar, Colombia, 2; Palma Sola and Tachira, Venezuela, 2: *ditzleri,* 5; Puerto Barrios, Guatemala, 1; Puerto Berrio, Colombia, 1; Palma Sola, El Guayabo and La Fria, Venezuela, 3: *caribbea,* 5; Santa Marta and Bolivar Colombia, 3; Palma Sola and Boqueron, Venezuela, 2: *trifida,* 5; California, 1; Georgia, 1; Guanajay, Cuba, 1; Hayti, 1; Bath, Jamaica, 1: *satyrus,* 3; Banana River, Costa Rica, 1; La Fria, Venezuela, 1; Bartica, British Guiana, 1: *Gynacantha laticeps,* 2; Minas Geraes, Brazil: *aratrix,* Martin 25, figure 182: *adela,* 3, Yungas, Bolivia: *convergens,* 1, Jujuy, Argentina: *tenuis,* 5; La Fria, Venezuela, 3; Iquitos, Peru, 1; Tamanoir, French Guiana, 1: *caudata,* 1, San Rafael, Ecuador: *tibiata,* 5; Colima, Mexico, 1; Ontario Farm and Cimarones, Costa Rica, 3; La Fria, Venezuela, 1; *jessei,* 1, Puerto Berrio, Colombia: *auricularis,* 3; Palma Sola, Venezuela, 1; Bartica, British Guiana, 1; Oyapok River, French Guiana, 1: *klagesi,* 2, Tamanoir, French Guiana: *creagris,* 2, Havana, Cuba: *mexicana,* 5; Fundacion, Colombia, 1; Palma Sola and Bejuma, Venezuela, 3; Para, Brazil, 1: *nervosa,* 5; Bolivar and Cristalina, Colombia, 2; Palma Sola and La Fria, Venezuela, 2; Rockstone, British Guiana, 1: *bifida,* 3; Porto Catherina de Santa Leopoldina, Brazil, 2; Jujuy, Argentina, 1: *croceipennis,* 2, Rio Songo, Bolivia: *litoralis,* 3; Paramaribo, Dutch Guiana, 1; Manaos, Brazil, 2: *interioris,* 4; Peru, 3; Santarem, Brazil, 1: *gracilis,* 2; Ontario Farm, Costa Rica, 1; Kartabo, British Guiana, 1: *membranalis,* 5; Rio Negro, Colombia, 1; San Esteban and La Fria, Venezuela, 2; Rockstone, British Guiana, 1; Tamanoir, French Guiana, 1.

In the tabulation each number is the per cent of the total number of wings examined. Some numbers are followed by letters, which are explained on page 55.

Explanation of Letters in Venational Tabulation

a. One present in one left front wing.

b. In one wing a minute fourth cell formed by a forking, near its distal end, of the crossvein.

c. Two wings each with one crossvein forked, and three wings each with a single double cell.

d. Two for one cell's length in two wings and two for two cell's length in one wing.

e. One wing with two rows only one cell's length, and one wing with double and single cells interspersed.

f. One front wing with an antenodal of the first series basal to the first thickened antenodal.

g. Obviously an abnormal condition.

h. This is the Paramaribo specimen,—the type.

i. One present in one right hind wing.

j. Abnormal.

k. Left front wing with added basal crossvein in both series; absent in right front wing and left hind wing; right hind wing with an added crossvein in the second series.

l. In both cases anal loop apparently malformed.

m. In two wings there are some single cells between the anal loop and the hind wing margin.

n. In the left front wing and left hind wing of one specimen M_3, beyond the loop of M_4, is diverted or switched anteriorly one row of cells, resulting in three rows of cells between M_3 and M_4. This is the only case observed in all the wings examined in this study in which a main sector is so diverted.

o. One row of two cells.

p. Two for one-two cell's length.

q. Abnormal.

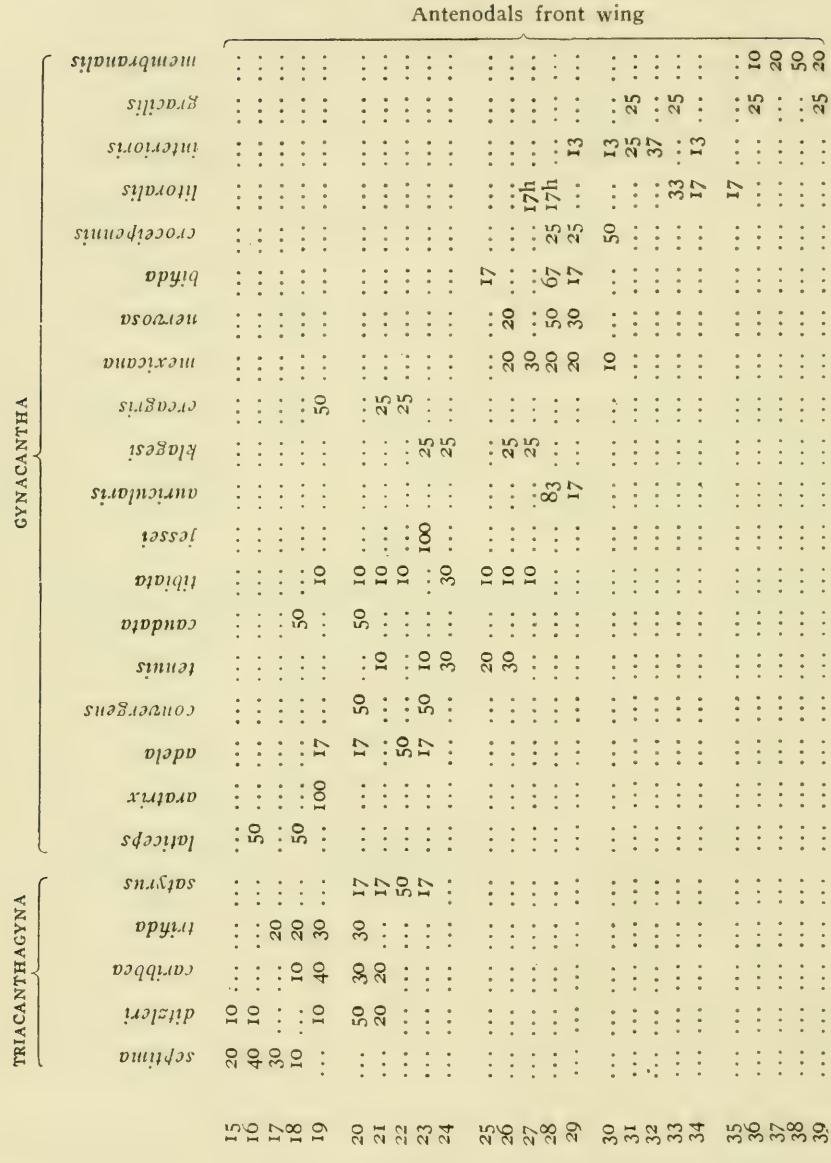
r. Abnormal.

s. In each case the fourth cell is small, interpolated.

t. In one wing the cubital space is two cells wide for a distance of three cells.

u. In one wing a few rows of three cells.

VENATIONAL TABULATION

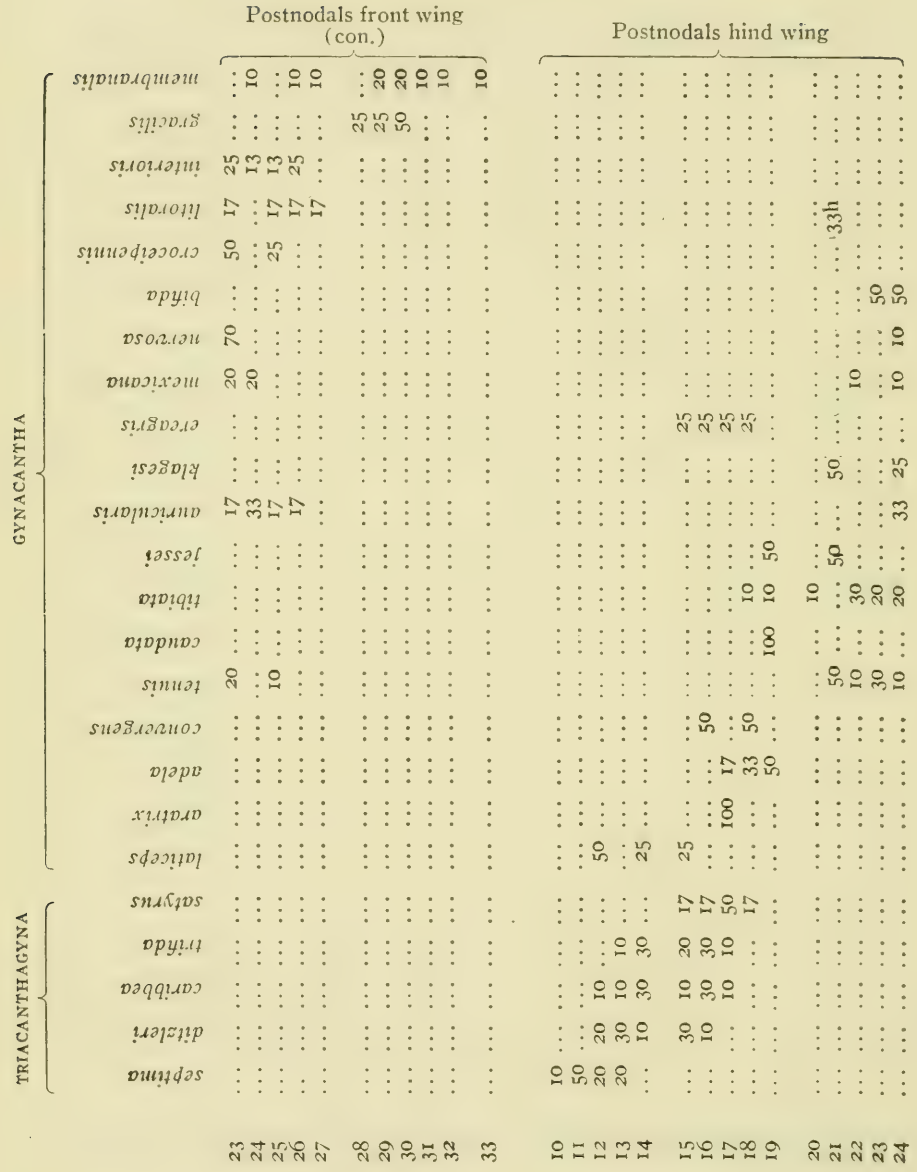


VENATIONAL TABULATION

Antenodals hind wing

| | | |

VENATIONAL TABULATION



VENATIONAL TABULATION

| | Postnodals hind wing (con.) | | |

VENATIONAL TABULATION

		Number cells in triangle hind wing																				Number cells in triangle front wing																				
		septima	*dilatari*	*caribbea*	*trifida*	*salyrus*	*laticeps*	*arafrix*	*adela*	*convergens*	*tenuis*	*caudata*	*tibiata*	*jessei*	*auricularis*	*klagesi*	*creagris*	*mexicana*	*nervosa*	*bifida*	*crocelpennis*	*litoralis*	*interioris*	*gracilis*	*membranalis*		*septima*	*dilatari*	*caribbea*	*trifida*	*salyrus*	*laticeps*	*arafrix*	*adela*	*convergens*	*tenuis*	*caudata*	*tibiata*	*jessei*	*auricularis*	*klagesi*	*creagris*	*mexicana*	*nervosa*	*bifida*	*crocelpennis*	*litoralis*	*interioris*	*gracilis*	*membranalis*	
TRIACANTHAGYNA							GYNACANTHA																																								
4		20	...	...	...	...	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
5		60	40	10	30	17	100	...	17	100	...	50	...	...	...	25	...	...	...	...	...	...	...	...	...		20	...	...	...	...	50	...	17	100	...	50	...	...	...	...	...	...	...	...	...	...	...	...	...	
6		20	60	90	70	67	...	...	83	...	80	50	50	50	...	25	75	...	...	...	...	...	17	25	75		60	40	10	30	17	100	...	17	100	...	50	...	...	...	...	...	...	...	...	...	...	...	...	...	
7		...	...	...	...	17	...	100	...	...	20	...	50	50	33	75	...	10	20	17	...	...	17	33	13	40		20	60	90	70	67	...	100	...	83	...	80	50	50	50	25	75	...	10	20	17	...	...	17	33	13	40
8		...	...	...	...	...	...	...	...	...	...	...	...	50	67	...	...	40	20	33	50	17h	...	...	...	20		...	...	...	...	17	...	...	...	...	20	...	33	67	...	40	20	33	50	17h	...	...	...	...	20
9		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50	50	50	50	17h	63	...	...	10		...	...	...	...	...	...	...	...	...	...	...	...	...	...	50	50	50	50	17h	63	...	...	10
10		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10	10	...	...	17	25	75		40		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10	...	...	17	25	75		40
11		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33	13		20		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33	13		20
12		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17	...		10		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17	...		10
13		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25		10		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25		10
15		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		10		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		20

VENATIONAL TABULATION

Number cubito-anal crossveins basal to subtriangle in front wing

| | | |

VENATIONAL TABULATION

| | | Number of cells in anal triangle | | |

VENATIONAL TABULATION

Number of rows of cells in fork of R_5 posterior to stigma in front wing	Number of rows of cells between anal loop and posterior wing margin	Number of cells in anal loop
2	1	5
2 and 3	2	6
3	2 and 3	7
4	3	8
5	3 and 4	9
		10
		11
		12
		13
		14
		15
		16
		17
		18
		19
		20

Number of rows of cells in fork of R_5 posterior to stigma in front wing	Number of rows of cells between anal loop and posterior wing margin	Number of cells in anal loop																			
2	1	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2 and 3	2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3	2 and 3	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4	3	8	9	10	11	12	13	14	15	16	17	18	19	20
5	3 and 4	9	10	11	12	13	14	15	16	17	18	19	20
10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
90	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
100	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
100	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
67	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
33	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	100	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	100	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	100	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	100	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	50	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	50	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...

VENATIONAL TABULATION

| | | Maximum number of rows of cells between Rs and Rspl in hind wing | | | | | | | | | | | | | | | | | | | | | | | | | Maximum number of rows of cells between Rs and Rspl in front wing | | | | | | | | | | | | | | | | | | | | | | | | | Number of rows of cells in fork of R posterior to stigma in hind wing | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---

VENATIONAL TABULATION

| | Number of rows of cells between M3 and M4 following the loop in M4 in front wing | | |

VENATIONAL TABULATION

		Number of cells in the anterior row of cells in the anal loop				Number of rows of cells between Cu_1 and Cu_2 posterior to the triangle in the hind wing																						Number of rows of cells between M3 and M4 following the loop in M4 in hind wing			
		2	3	4		1	1 and 2	2																				1	2		
TRIACANTHAGYNA	*sephina*	40	60	...		100	...	...																				100	...		
	ditzleri	100	...	...		100	...	...																				100	...		
	caribbea	10	90	...		100c	...	...																				100	...		
	trifida	...	100	...		100	...	...																				100	...		
	salyrus	...	100	...		100	...	...																				100	...		
GYNACANTHA	*laticeps*	25r	75	...		100	...	...																				100	100		
	avatrix	100	100	...		100	...	...																				100	...		
	adela	100	100	...		1000	...	...																				50	50		
	concergens	100	100	...		100h	...	...																				50	40		
	tenuis	100	100	...		100	...	...																				50n	60		
	caudata	100	100	...		100	...	...																				...	...		
	tibiata	100	100	...		100	...	...																				100	100		
	jessei	50j	50	...		100	...	...																				100	100		
	auricularis	...	83	17		100	...	...																				...	...		
	blagesi	50	50	...		100	...	...																				100	...		
	creagris	25q	75	...		...	100	...																				...	100		
	mexicana	...	100	...		100d	...	...																				...	...		
	mercosa	...	100	...		20	...	80																				...	...		
	bifida	...	100	...		...	17	83																				...	...		
	crocelpennis	...	100	...		...	50	50																				...	...		
	litoralis	83	17	...		...	...	100																				...	...		
	interioris	100	...	...		...	...	100e																				...	...		
	gracilis	50	50	...		...	100	...																				...	...		
	membranalis	70	30	...		...	...	100																				10	90		

VENATIONAL TABULATION

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PLATE I

Wing photographs by Miss Mina L. Winslow.

Figure 1, *Triacanthagyna septima,* male, Palma Sola, Venezuela, March 5, 1920; Figure 2, *T. ditzleri,* male, Puerto Berrio, Colombia, January 31, 1917; Figure 3, *T. caribbea,* male, Santa Marta, Colombia, December 14, 1916; Figure 4, *Gynacantha laticeps,* male, Minas Geraes, Brazil.

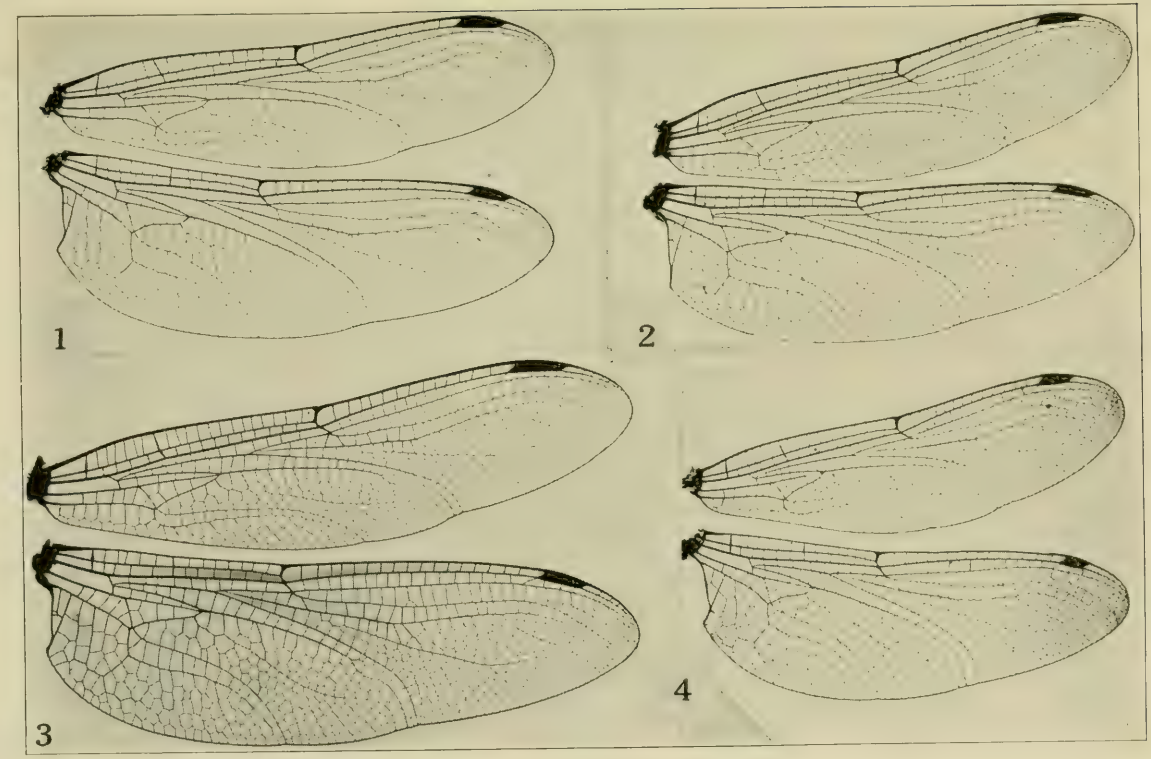
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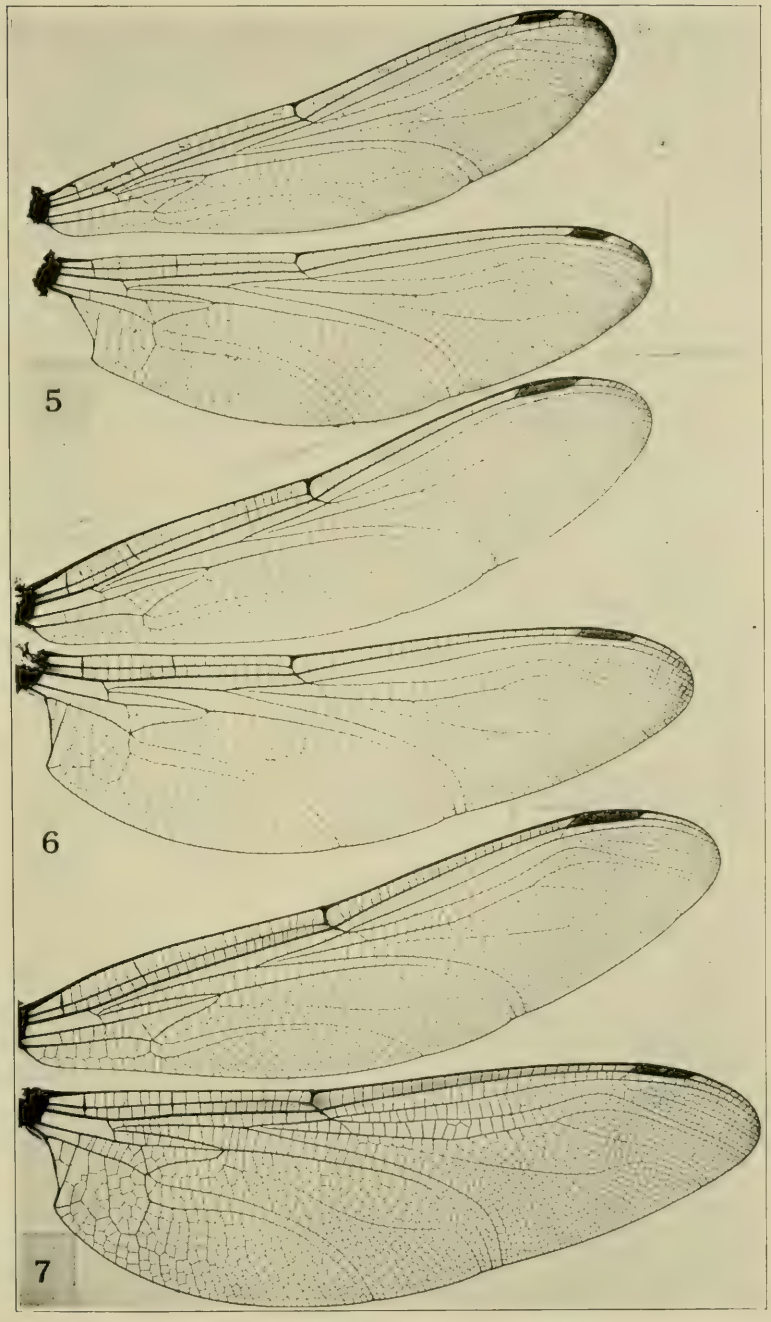
PLATE II

Wing photographs by Miss Mina L. Winslow.

Figure 5, *Gynacantha tenuis,* male, La Fria, Venezuela, April 12, 1920; Figure 6, *G. mexicana,* male, Bejuma, Venezuela, February 17, 1920; Figure 7, *G. nervosa,* male, Palma Sola, Venezuela, March 6, 1920.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6
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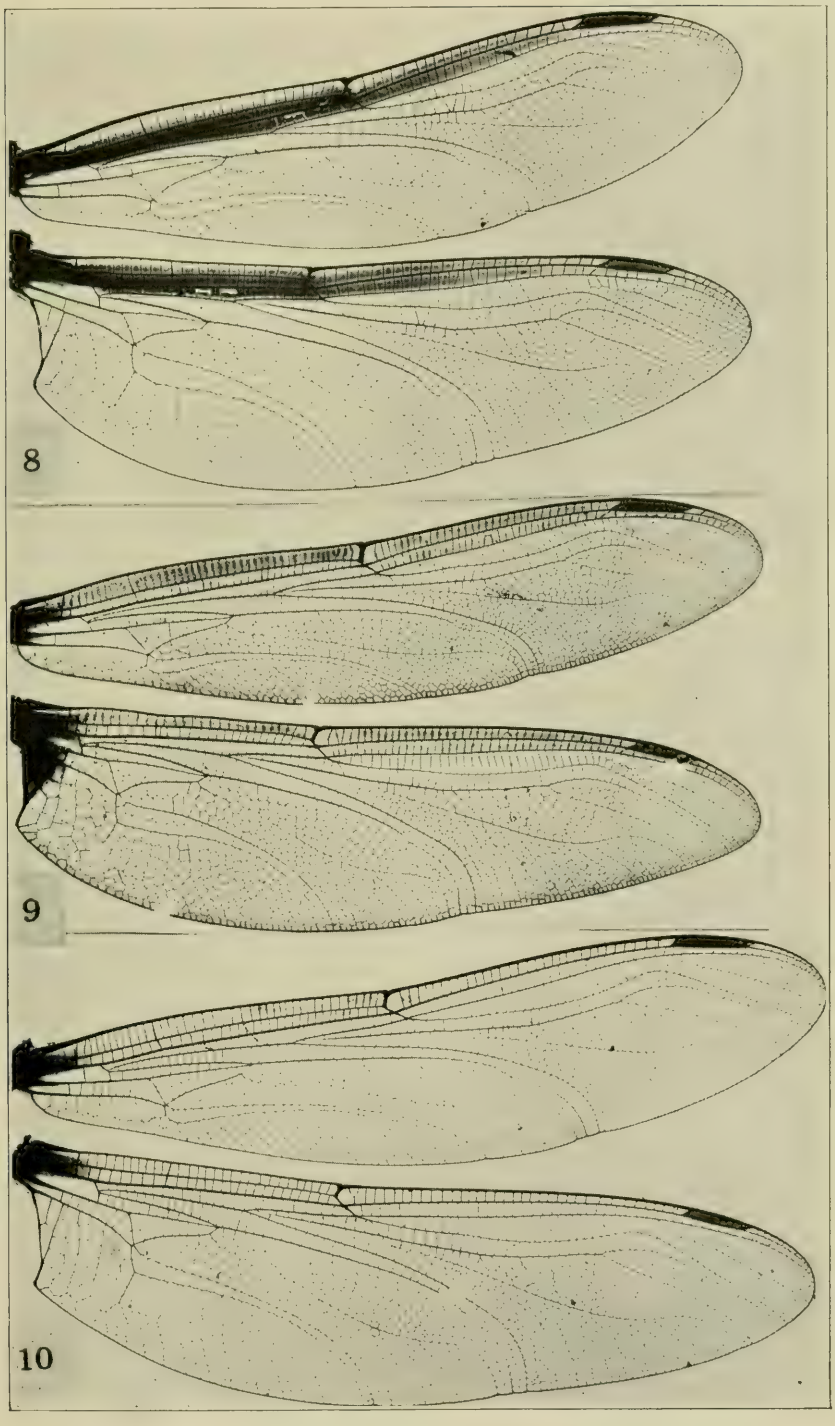
PLATE III

Wing photographs by Miss Mina L. Winslow.

Figure 8, *Gynacantha interioris,* male, Colonia del Perené, Peru; Figure 9, *G. membranalis,* male, La Fria, Venezuela, April 21, 1920; Figure 10, *G. gracilis,* La Fria, Venezuela, April 12, 1920.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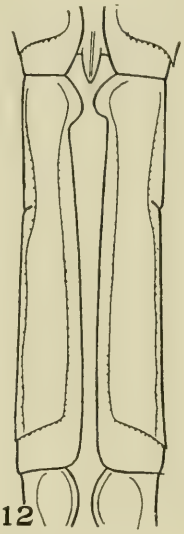
9
10

PLATE IV

Figures 11-15, ventral views of third abdominal segments; Figure 16, ventral view of second abdominal segment; Figures 17-20, hamular processes. All drawings by Dr. C. H. Kennedy.

Figure 11, *Gynacantha nervosa,* male, Palma Sola, Venezuela, March 6, 1920; Figure 12, *G. nervosa,* female, Palma Sola, Venezuela, March 4, 1920; Figure 13, *Triacanthagyna ditzleri,* allotype female; Figure 14, *T. trifida,* female, Samana, Hayti, M. C. Z.; Figure 15, *T. caribbea,* allotype female; Figure 16, *Gynacantha klagesi,* allotype female, to show elevated lateral carinæ; Figure 17, *T. ditzleri,* type male; Figure 18, *T. caribbea,* type male; Figure 19, *T. trifida,* male, Samana, Hayti, M. C. Z.; Figure 20, *T. satyrus,* male, La Fria, Venezuela.

11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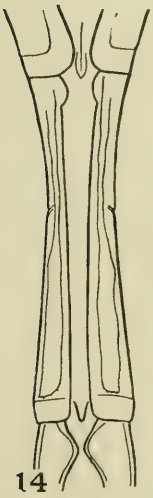
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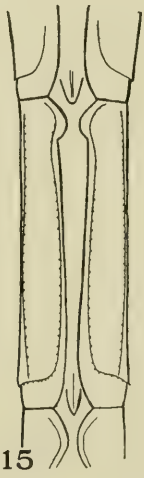
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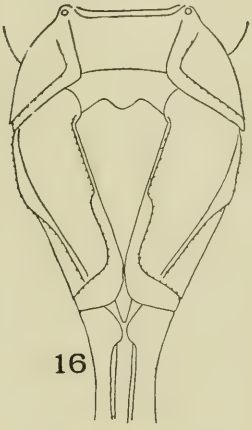
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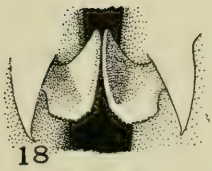
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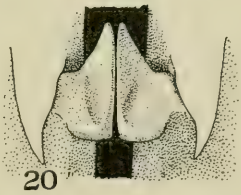

20

PLATE V

Figures 21-29, male abdominal appendages in dorsal and lateral views. All drawings by Dr. C. H. Kennedy.

Figure 21, *Triacanthagyna septima,* Rio Frio, Colombia, January 7, 1917; Figure 22, *T. ditzleri,* type; Fig. 23, *T. caribbea* type, figure at left, appendages in supero-internal view; Figure 24, *T. trifida* Samana, Hayti, M. C. Z.; Figure 25, *T. satyrus,* La Fria, Venezuela; Figure 26, *Gynacantha laticeps,* type; Figure 27, *G. chelifera,* after Figure 174, Martin 25; Figure 28, *G. aratrix,* after Figure 183, Martin 25; Figure 29, *G. convergens,* Yuto, Jujuy, Argentina, April, 1911.

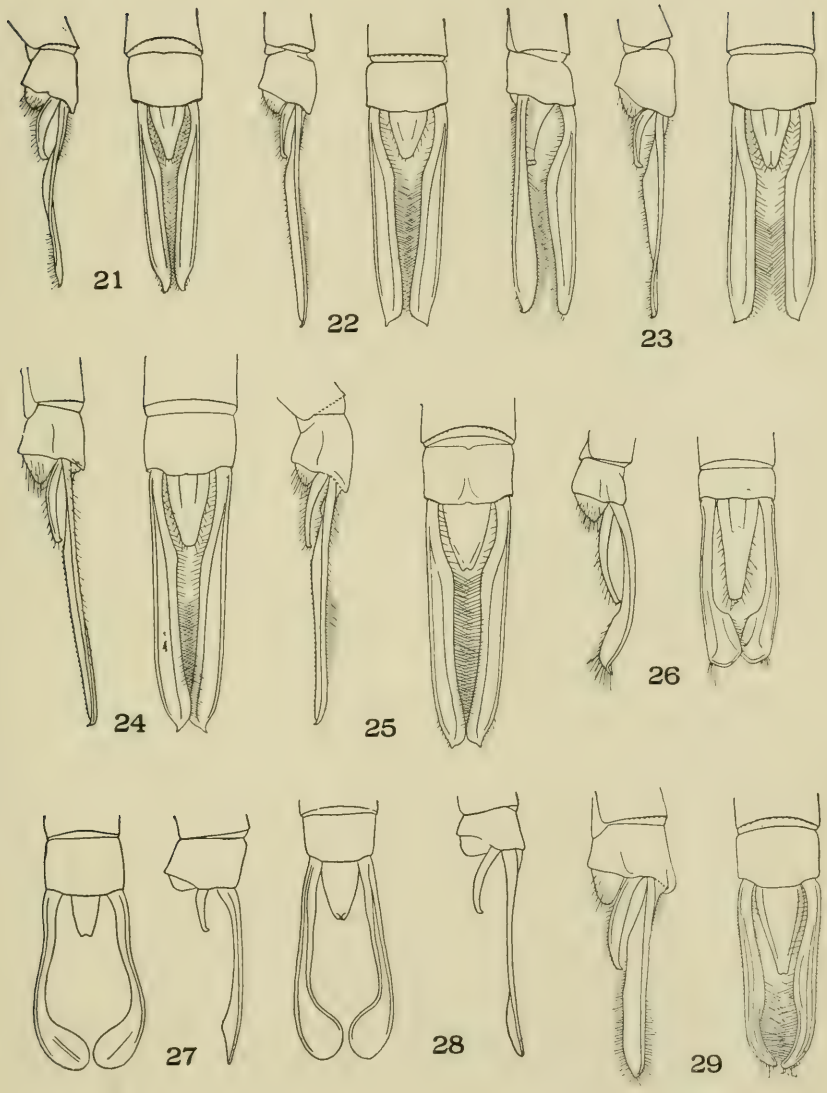

21
22
23
24
25
26
27
28
29

PLATE VI

Figures 30-38, Male abdominal appendages in dorsal and lateral views. All drawings by Dr. C. H. Kennedy.

Figure 30, *Gynacantha adela,* near Coroico, Yungas, Bolivia, May 4, 1899; Figure 31, *G. tenuis,* La Fria, Venezuela, April 16, 1920; Figure 32, *G. caudata,* San Rafael, Ecuador; Figure 33, *G. tibiata,* La Fria, Venezuela, April 13, 1920; Figure 34, *G. jessei,* type; Figure 35, *G. auricularis,* Palma Sola, Venezuela, March 6, 1920; Figure 36, *G. klagesi* type; Figure 37, *G. gracilis,* Mte. Christo, Tapajos, Brazil, May, 1920; Figure 38, *G. membranalis,* San Esteban, Venezuela, Feb. 9, 1920.

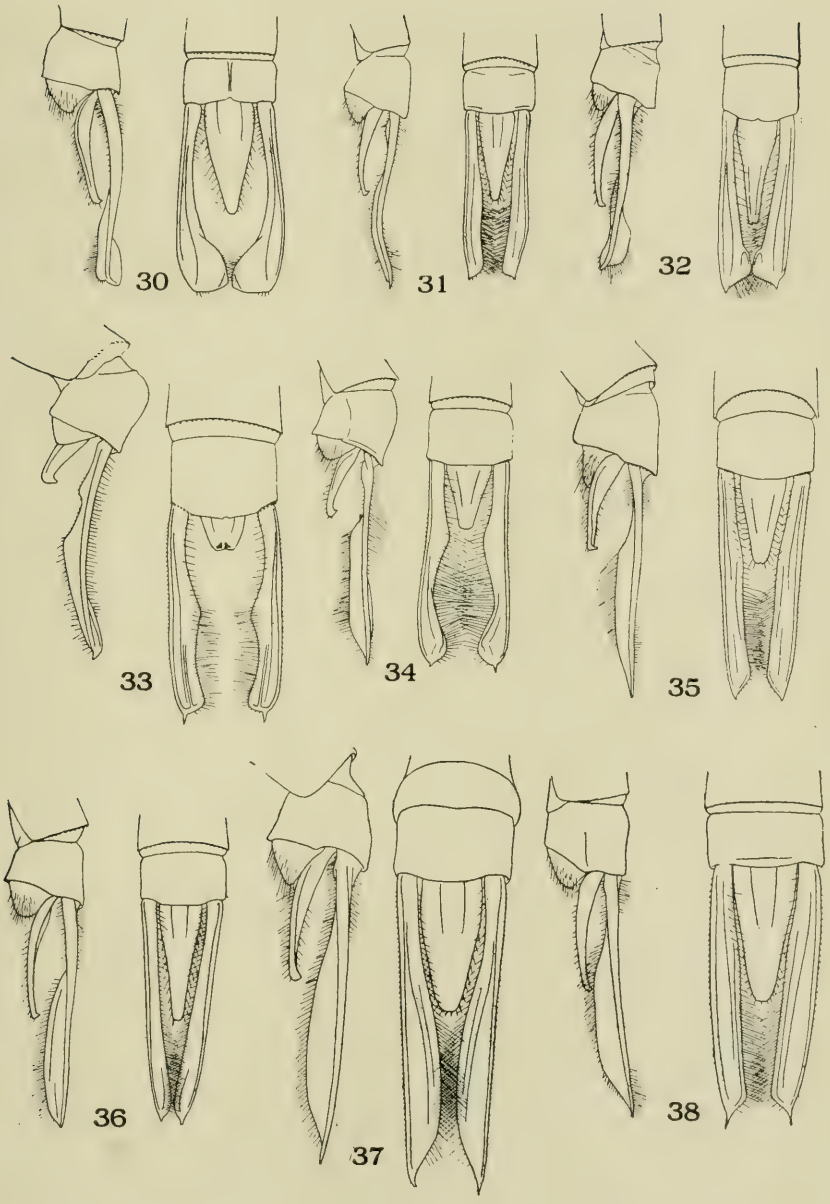
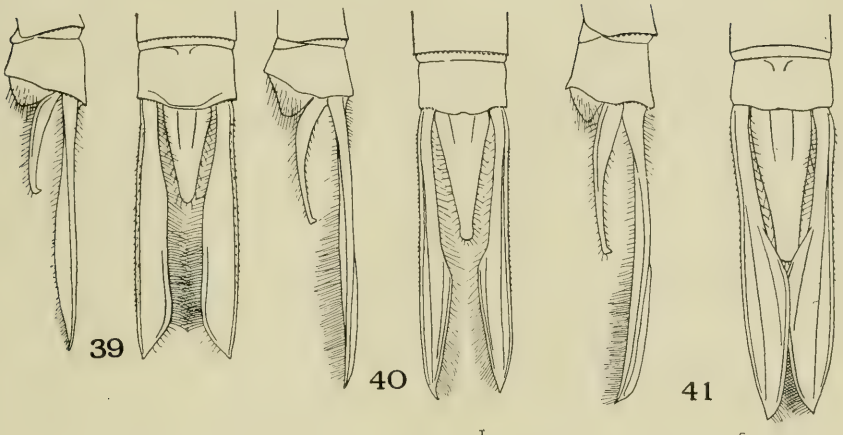

30
31
32
33
34
35
36
37
38

PLATE VII

Figures 39-45, male abdominal appendages in dorsal and lateral views. All drawings by Dr. C. H. Kennedy.

Figure 39, *Gynacantha mexicana,* Fundacion, Colombia, January 9, 1917; Figure 40, *G. creagris,* Havana, Cuba, Baker; Figure 41, *G. nervosa,* Palma Sola, Venezuela, March 6, 1920; Figure 42, *G. bifida,* Porto Catherina de Santa Leopoldina, Brazil; Figure 43, *G. croceipennis,* Rio Songo, Bolivia, Fassl; Figure 44, *G. litoralis,* type; Figure 45, *G. interioris,* type.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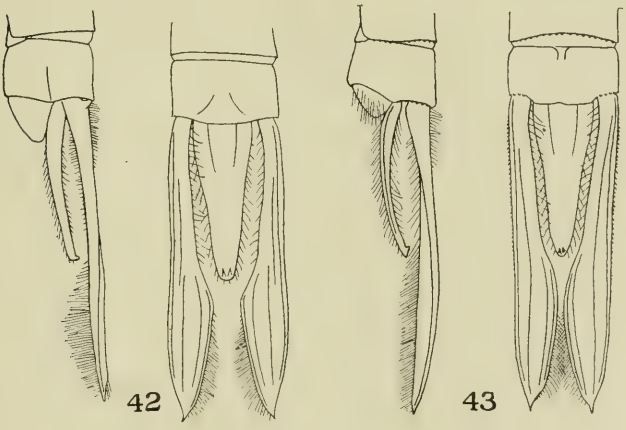
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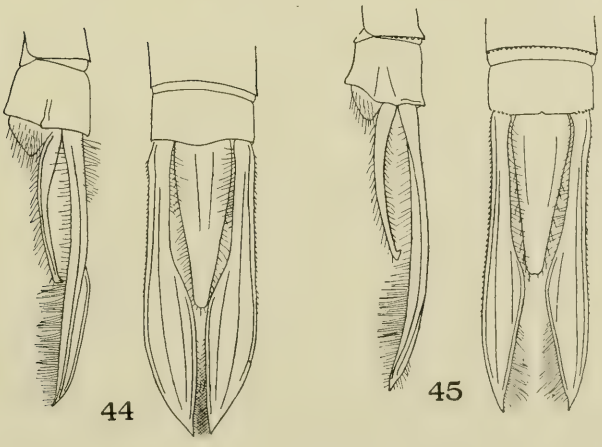
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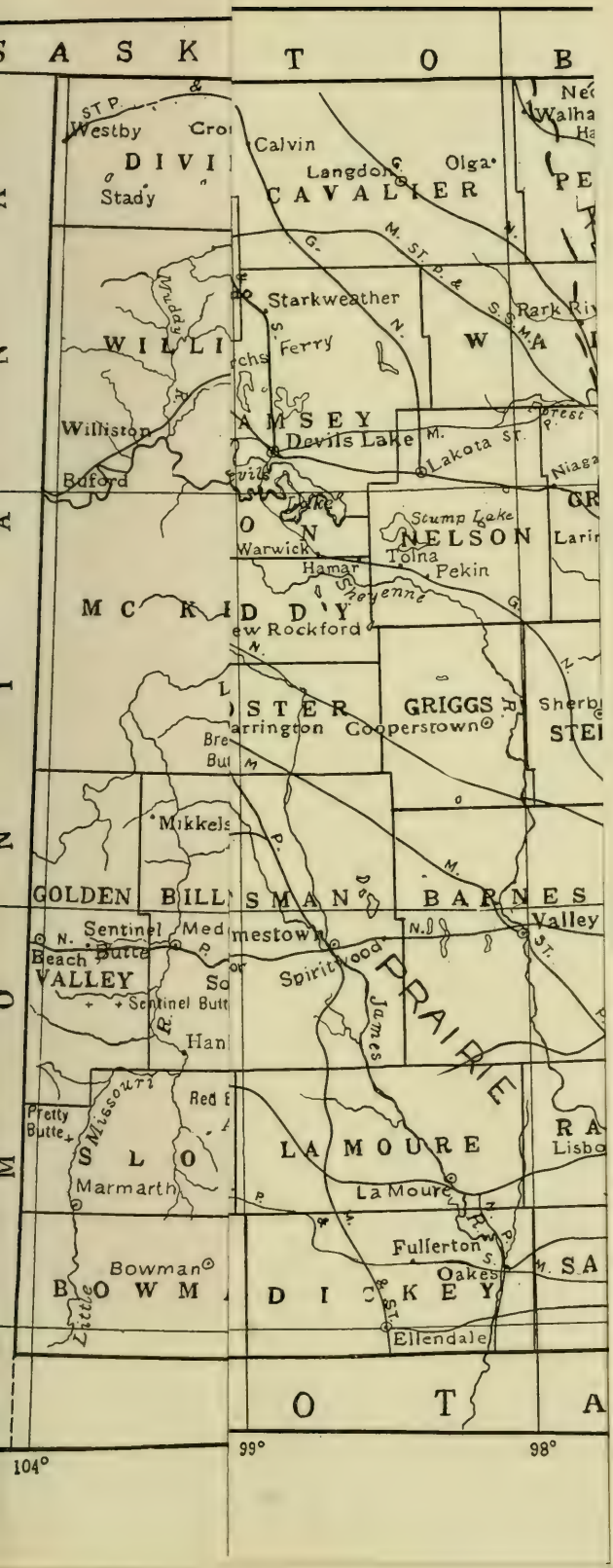
A S K
T O
B
Westby
Calvin
Langdon
Olga
Stady
CAVALIER
Starkweather
Ferry
Williston
Devils Lake
Lakota
Buford
Stump Lake
NELSON
Warwick
Tolna
Hamar
Pekin
Cheyenne
ew Rockford
GRIGGS
Cooperstown
Harrington
Mikkels
GOLDEN
BARNES
Valley
Sentinel
Beach
Butte
VALLEY
Spiritwood
PRAIRIE
James
Pretty
Butte
Missouri
LA MOURE
La Moure
Marmarth
Fullerton
Oakes
Bowman
DICKEY
Ellendale
O T A
104°
99°
98°

Bird

OUTLINE MAP OF NORTH DAKOTA

UNIVERSITY OF MICHIGAN

MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 10

A Preliminary Survey of the Bird Life of North Dakota

BY

NORMAN A. WOOD

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
JULY 2, 1923

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The publications of the Museum of Zoology, University of Michigan, consist of two series—the Occasional Papers and the Miscellaneous Publications. Both series were founded by Dr. Bryant Walker, Mr. Bradshaw H. Swales and Dr. W. W. Newcomb.

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

A PRELIMINARY SURVEY OF THE BIRD LIFE OF NORTH DAKOTA

By Norman A. Wood

The field studies upon which this paper is largely based were carried on during the summers of 1920 and 1921. The investigation was made possible through the coöperation of the State Biological Station of the University of North Dakota and the Museum of Zoology of the University of Michigan. It is a part of the program of a biological survey of the State of North Dakota, as undertaken by the State Biological Station and carried on under the direction of Crystal Thompson, Curator of the Station Museum.[1] Dr. R. T. Young, Director of the Station, has provided, through the Station, most of the funds necessary to carry on the work and has rendered every assistance in his power to make it a success. The Museum of Zoology of the University of Michigan has contributed traveling expenses to and from the field and the time of the investigator.

In 1920 work was carried on from July 12 to August 25, chiefly in the Devils-Stump Lake region, and a short trip was made to the Turtle Mountains.

In 1921 headquarters were made at the Station from May 2 until July 25. During this time several trips were made about the state. On June 1 I went to Cando, in Towner County. From here, at the invitation of Mr. Elmer T. Judd, an automobile trip was made across the county to the Canadian boundary and west into the Turtle Mountains, returning June 6 to Cando for a few days. On June 13 I went to the Bad Land country by way of Fargo and the Northern Pacific Railroad to Medora, Billings County. A few days were spent at Medora and a week at the Peaceful Valley Ranch, four miles north, owned by the Hon. Carl Olsen, who provided a trip through the Petrified Forest. On June 24 I went to Mr. William Shunk's ranch on the Sheyenne River near Anselm, Ransom County. A trip to Williston, Williams County, was made on July 5, and on July 15 another to Bottineau, Bottineau County. Here Mr. Alfred Eastgate, a noted guide and ornithologist, drove me over the prairies and up into the western part of the Turtle Mountains. July 21 to 30 was spent along the Red River at Fargo, Grand Forks, and Grafton. The collections of the Agricultural College, Fargo College, and the University were examined, and the large private collection of Mr. William Williams and his son at Grafton. Some field work was done at each of these places also. Travel of more than 2,000 miles, by rail and automobile, within the state gave much insight into the character

[1] I wish also to acknowledge the critical work of Crystal Thompson, who revised and edited this paper and to whom much credit is due for its systematic arrangement.

of the country upon which so much of its bird life depends, and the following list is the result of close observation and field work, as well as the records, published and unpublished, that I have been able to secure.

It should be understood that the list is far from complete, especially as to the distribution of species, but I hope that it may prove a basis for much future work along these lines.

ACKNOWLEDGMENTS

In compiling this list I have not only copied from the published data but have been given many valuable records by the following persons: Mr. Alfred Eastgate of Bottineau; Mr. Elmer T. Judd of Cando; Mr. William Shunk of Anselm; Mr. Metzger of Williston; Mr. D. R. Ducke of Jamestown; Mr. William Williams and Mr. Henry Williams of Grafton; Mrs. Lucia Olsen and Hon. Carl Olsen of Medora; Hon. Lewis Crawford of Sentinel Butte; Professor Daniel Freeman of Fargo; Professor C. C. Schmidt of Grand Forks; Professor R. T. Young of Grand Forks; Professor George Miller of Fargo; Mr. Russell Reid of Bismarck; Captain Lonnevik of Devils Lake; and Professor Howard Simpson of Grand Forks.

PREVIOUS WORK AND WORKERS

Although North Dakota is one of the newer states, parts of Dakota Territory have been visited since the early part of the eighteenth century by noted travellers and ornithologists. The Missouri River, since it furnished easy access to the interior of the state, was the route taken by many of them, and the frontier forts furnished favorable camping places.

The first expedition to visit the Dakota territory was that of La Verendrye, who with a party of 52 persons left Fort La Reine, below the mouth of the Assinaboine, October 18, 1738. They arrived at the Mandan Village, lat. 48° 12′, December 3. They remained here ten days, returning to Fort La Reine February 10, 1739. This expedition was made at a season of the year when little animal life was to be found in the region. The only animal mentioned is the bison which furnished food for the party.

The Lewis and Clark Expedition was the first scientific party to visit the region. Starting from St. Louis on May 14, 1804, they reached the 46th parallel (North Dakota) on October 15, 1804. Here they built Fort Mandan and spent the winter. Leaving the fort on April 7, 1805, they journeyed up the Missouri River to the Montana line, which they reached July 27, 1805. Many birds were observed and some were noted in the daily journals. These early North Dakota records have been placed in the state list in regular order.

Prince Maximilian of Wied visited North Dakota in 1833, going by boat from St. Louis and reaching Fort Clark on June 18, 1833. He arrived at the mouth of the Yellowstone on June 24 and spent two weeks at Fort Union. He then continued up the river to Fort MacKenzie, returning to Fort Union on September 29. Here he worked until October 30, when he returned down

the river to Fort Clark, where he spent the winter. His journals contain some notes on birds which are recorded in the list.

John J. Audubon visited the region in 1843. Leaving St. Louis, April 25, he journeyed up the Missouri River by steamboat, reaching Fort Union on June 12. At Fort Union he collected many new birds and made drawings of birds and mammals. August 16 he started with his party down the river in a forty-foot barge, "The Union," reaching St. Louis, September 19. A daily journal was kept in which he mentioned seeing many species of birds. These records have been added to the list under each species noted.

J. A. Allen, as naturalist for the Northern Pacific Railroad Exploration, worked overland from Fort Rice (June, 1873), on the Missouri, along the Heart River and across the Little Missouri into Montana. He returned in September through the same general region. His report on birds consists of several local lists and an annotated list of 118 species. This list is of exceptional importance because the observations were made before the country was broken up and settled and because this region is perhaps the least well known of any section of the state.

Dr. Elliot Coues, as ornithologist of the Hayden Survey, went by boat from Moorehead down the Red River to Pembina in the latter part of May, 1873. He collected there for nearly a month, then worked along the international boundary line to the Turtle Mountains and Mouse River, making numerous collections and notes covering 183 species of birds.

In 1895, from late March until August, a party consisting of Dr. L. B. Bishop, W. H. Hoyt, John Shaler, N. L. Bigelow, and Elmer T. Judd collected many specimens of birds in Towner and Rolette counties.

The type of the Dakota song sparrow was taken at Rock Lake, and the type of Hoyts' horned lark was collected at Cando in Towner County by Dr. Bishop, who described and named both. The notes on species taken here (some 220) were later supplemented by others made by E. S. Bryant, who collected at Dry Lake, Freshwater Lake, and Devils Lake in 1892, 1898, and 1906. Since that time Mr. Judd has added some 20 species and in 1917 published a list of 255 species.

During the last of May and the first half of June, 1901, Mr. A. C. Bent visited the Devils-Stump Lake region for data on the life histories of North American diving birds. He was accompanied by the Rev. H. K. Job and Dr. L. B. Bishop.

Mr. W. L. Stockwell, Superintendent of Public Instruction, issued, April 15, 1904, a list of birds that had been observed in the state of North Dakota. This list of 339 species, compiled by C. C. Schmidt, includes all the names of birds sent to him from all observers. It includes many species, such as the sooty tern, willet, Guadalupe wren, and Kentucky and prothonotary warblers, that are geographically almost impossible in the state.

During the summer of 1913 Mrs. Florence Merriam Bailey visited the Devils-Stump Lake region and studied its bird life, which she has graphically and beautifully described in a series of articles in *Condor*.

In 1917 Mrs. Bailey returned to Dakota and visited all of the larger lakes and many of the ponds and sloughs. The results of this trip are likewise published in *Condor*.

In April, 1919, Professor Daniel Freeman published "A Bird Calendar of the Fargo Region." This list of 180 species is the result of several years' observation by Professor Freeman and his students. Some of the species have a little data and some annotations, but the list contains few actual records.

Professor C. C. Schmidt of the University of North Dakota published in 1921 a list of the birds of North Dakota in a book entitled "Nature Study and Agriculture." This is a popular list without records or dates of occurrence for the species.

Although the task of compiling a list like the present is often tedious, it has not been an irksome one to me, as the field work on which it is based has carried me thousands of miles across the level valleys, the "Prairie Plains" and the "Great Plains" of the state. I recall the wonderful "Buttes" of the Bad Lands along the Little Missouri in "Roosevelt Land," and the big, muddy Missouri that carried the pioneer ornithologists through the state. While I have been compiling the records and notes I have been constantly reminded of the many days spent by the lakes and ponds or wandering over the big, dry prairies.

However dry the text of this list may seem, back of it is a living Dakota with its wonderful and interesting bird life, worthy of much future study by bird lovers. To these I hope this list will be a help and an inspiration.

General Physiographic Features and Distributional Areas of North Dakota

While I have visited many parts of the state, my time in each one was too limited to permit me to obtain complete data on many of the species, and little has been published on this subject in the state lists. The problem of distribution is the hardest one given to the bird student, since species are not strictly confined to any one area, but are continually extending their range and passing from one area to another, as the character of the country changes. The state is divided geographically into three main areas, and the character of these areas in a great measure determines the characteristic bird life of each.

The discussion of the physiography of the state has been taken largely from "Topographic Features and Geological Formations of North Dakota," by A. G. Leonard,[2] and "Physiography of the Devils-Stump Lake Region, North Dakota," by Howard E. Simpson.[3]

The land surface included within the state may be regarded as formed of three plains rising one above the other. The lowest of these is the broad

[2] Third Biennial Report of State Geological Survey of North Dakota. Bismarck, 1904.

[3] Sixth Biennial Report of the State Geological Survey of North Dakota. Bismarck, 1912.

Red River Valley with an elevation of from 800-1000 feet. This is bordered on the west by a higher Drift Prairie Plain rising from 1,200 to 1,600 feet above the sea. Still farther west and occupying nearly one-half of the state is the elevated Coteau du Missouri with a surface which rises from 1,800 to 2,700 feet and more above sea level. The state thus represents a considerable range of relief, the lowest point in the northeastern corner being 789 feet above the sea; the highest yet determined, the summit of Sentinel Butte, over 3,100 feet.

The Red River Valley

The Red River Valley is not a true valley but an old lake plain, northward along the axis of which flows the Red River of the North. The plain is remarkable for its larger level areas and for the fertile soil-lacustrine deposits of silts and clays found on the floor of the ancient glacial-marginal lake, Lake Agassiz. The portion of the plain which lies within North Dakota has a breadth of thirty to forty miles, except at the south, where it narrows to ten miles, and an elevation of from about 800 feet at Pembina to about 975 near Wahpeton.

The boundary between the Red River Valley and the Drift-Prairie Plain is an escarpment so abrupt and rugged in the north as to receive the name of Pembina Mountain. The wooded and dissected character of the bluff accents the contrast with the old lake floor. Near the middle of the state the escarpment fades into a gentle and inconspicuous slope and becomes somewhat more marked again as the south state line is approached. Throughout the entire distance across North Dakota the escarpment bordering the Drift-Prairie Plain on the east rises 300 to 500 feet above the Red River Valley floor; in some places the slope is abrupt, in others gentle, but always it is conspicuous in this country of low relief.

The Red River seems to be the dividing line between several eastern and western species, although Coues (1878, p. 546) says: The bird fauna of this region is decidedly eastern in character, and of the Pembina region, the only western trace observed was clay-colored sparrows and Brewer's blackbird. The whip-poor-will, pileated woodpecker, crested flycatcher, phoebe, wood duck, indigo bunting, and screech owl rarely pass westward of the Red River and its valley, while of the western species, the magpie, burrowing owl, Arkansas kingbird (which Dr. Coues did not find in this valley in 1873) now are common as far east as the Red River itself. Several species that Dr. Coues found common in this valley in 1873 have now almost disappeared from the region, and one, the passenger pigeon, has become extinct here as elsewhere.

The Drift-Prairie Plain

The Drift-Prairie Plain extends from the Red River Valley escarpment on the east to the Coteau du Missouri escarpment on the west. The western escarpment runs from northwest to southeast, passing near Kenmare, Minot

and Steele. The plain varies in width from about 200 miles at the north to 100 miles at the south and has a general elevation of from 1,500 to 1,800 feet above sea level. It has a gradual, gentle slope eastward from the Coteau du Missouri and southward from the international boundary to the South Dakota line. This double slope determines the direction of the drainage and causes the main streams to take a general southeasterly course.

The topography of the plain varies from gently undulating to hilly, the differences being due almost entirely to the original disposition of unmodified glacial drift upon a nearly level plain. A few low, well-rounded hills, Sully's Hill, Devil's Heart and Blue Hills, partially concealed by drift, are remnants of older continuous formations now all but eroded away. Other less conspicuous hills are to be found stretching across the prairie in a northwest to southeast direction. The plain is cut by a few abnormally deep and well-defined valleys, such as those of the James and Sheyenne rivers. Hundreds of small lakes, marshy areas, coulees and swales dot its surface.

In marked contrast to the general topography of the plain are the Turtle Mountains and the Mouse River Valley. Each of these resembles one of the other physiographic regions of the state, and their location within the border of the Drift-Prairie Plain and their peculiar relation to one another still further emphasize the transitional character of this middle plain.

The Turtle Mountains are a rough, moraine-covered tableland lying midway on the Canadian boundary line. They have an area of 600 to 800 square miles and rise, mesa-like, 400 to 800 feet above the surrounding plain, their margin forming a gentle but conspicuous escarpment on all sides. Lakes abound, and this upland is on the whole well timbered and well watered, but poorly drained. The Turtle Mountains seem to be an isolated residuum of strata elsewhere eroded back to the Coteau du Missouri.

This comparatively small but distinct habitat, well wooded and watered, furnishes a suitable breeding habitat for several species rarely found elsewhere in the state. These are Grinnell's water thrush, Philadelphia vireo, yellow-bellied sapsucker, mourning warbler, black and white warbler, and hairy woodpecker. The sandhill crane and great blue heron, ruddy and canvas-back ducks, and the western great horned owl also breed here.

The Mouse River Valley is a glacial lake plain, similar to that of the Red River Valley, the floor of which was formerly covered by the waters of Lake Souris. This plain lies between 1,100 and 1,600 feet above sea level and drains northward through the Mouse River.

One of the most striking features of the Drift-Prairie Plain is the Devils-Stump Lake basin. The basin extends from the southern slopes of the Turtle Mountains and the Canadian boundary southward to a series of prominent hills lying between Devils and Stump lakes and the Sheyenne River. The eastern and western boundary lines are indistinct, but the area of the entire drainage basin is about 3,500 square miles. There is a gradual slope throughout the basin southward to Devils and Stump lakes. The fall is so slight that drainage is poor and small lakes and ponds abound. The coulees are few and shallow and rarely contain running water except in

wet seasons. Formerly these coulees and the chain of lakes connected by them emptied considerable water into Devils Lake through Mauvaise Coulee and by several converging coulees into both the eastern and western arms of Stump Lake. The headwaters of Mauvaise Coulee, the most important drainage line of the basin, were gathered beyond the international boundary line, and in its course southward it drained the Sweetwater chain of lakes by Lake Irvine, through which it passed, and entered Mauvaise Bay of Devils Lake as a large and permanent stream. Today no surface streams flow into either Devils Lake or Stump Lake except very minor flows during spring thaws and after excessive falls of rain. The waters of Devils and Stump lakes are decidedly alkaline, as are those of nearly all the other lakes in the general region. The notable exceptions are Sweetwater, Court, and Fort Totten lakes, which are fresh.

Devils Lake is characterized by broad, shallow and irregular bays connected by "narrows." On the north and south sides of Devils Lake, near the middle, is considerable hardwood timber. The woods come close to the lake and on the southern side are limited chiefly to the northern slopes of Sully's Hill.

This central area, the Devils-Stump Lake region, furnishes a very distinctive habitat and is occupied as a breeding ground by thousands of water-loving birds. Some of the more characteristic are the double-crested cormorant, grebes, common and black terns, Franklin's gull, white-winged scoter, pintail, redhead, goldeneye, blue-winged teal, mallard, and baldpate. The upland plover was formerly common, as is now the purple martin, tree swallow, Wilson phalarope, and belted piping plover.

South from this central area the Drift-Prairie is contracted to less than one-half of its northern width and contains the Sheyenne and James rivers with their valleys. These different areas give a great variety of habitats and all have some characteristic breeding birds.

The Great Plains

On the western border of the Drift-Prairie Plain rises the similar and even more abrupt escarpment of the Great Plains plateau known as the Coteau du Missouri. This plateau occupies fully one-half of the state and its irregular surface varies in elevation from 1,800 to 2,700 feet above the sea. The relief is due to the effects of erosion, and only in the eastern section has the surface resulted from ice action. By far the most interesting feature of the unglaciated region is the famous Bad Lands, typically developed along the Little Missouri. The true Bad Lands, that is, the very rough areas that are difficult to travel through, are confined to the vicinity of streams. Back from these for six miles the land is a rolling plain and is not "bad."

The soft cretaceous clays and sands have been carved by running water into a multitude of steep-sided hills, isolated buttes and an endless variety of fantastic forms. The erosion is greatly facilitated by the sparseness of

vegetation, the slopes being almost bare. The rainfall in the region is light, but every shower is highly effective in washing away the clays and sands.

The Missouri River flows in a valley from one to several miles in width and 200 to 400 feet in depth. It has a broad flood plain, above which lie one or more terraces or flats, and back of these rise the bluffs. The Little Missouri, Cannon Ball, Heart and Knife rivers, chief tributaries of the Missouri, have all cut their valleys from 100 to 400 feet below the upland plain and have more or less well-developed flood plains bordered by terraces. There are frequent wooded areas along these streams.

East of the Missouri River, in the north, the characteristic species are the lark bunting, McCown's longspur, and Say's phoebe, while the southern part is much like the Drift-Prairie, as many eastern species, such as the bobolink and dickcissel, follow up the valley of the Missouri. In the Bad Lands along the Little Missouri the many buttes and high, dry plateaus furnish a barren habitat for desert horned larks, western lark sparrows, magpies, and long-billed curlews. The groves of cottonwoods along the river furnish suitable habitats for a few distinctly western species, such as Bullock's oriole, black-headed grosbeak, lazuli bunting, long-tailed chat, Arctic towhee, and the mountain bluebird. West of the Bad Lands are the high sage brush plains with their characteristic bird, the sage grouse. This is the only North Dakota breeding ground of the species.

North Dakota is a state that has developed very rapidly, and in the last twenty years there have been great changes in the character of the country, which also affects its bird life, and direct changes in the bird life as well. The breaking up of the prairies has greatly restricted the range of many characteristic species (as the long-billed curlew, upland plover, and Baird's sparrow). From various causes many lakes, ponds, and sloughs have dried up, causing a great restriction of the habitats and nesting grounds of the numerous waders and waterfowl that formerly occurred in immense numbers. Many of the most interesting species are now rare. The trumpeter swan, the sandhill and whooping cranes are no longer common and, with the upland plover and long-billed curlew, are on the way to extinction in the state. While man with his civilization drives away or destroys some species, others, the prairie hen, bobolink, dickcissel, robin, bluebird, and martin, follow and increase with the settling of the land. The cause of these changes in bird life is the rapid settlement of the country, which changes the prairies into cultivated farms, the ponds and sloughs into hay meadows or grain fields. Some waders, like the killdeer and spotted sandpiper can adapt themselves to these changed conditions and thrive and increase in the settled country; but others, like the upland plover and the long-billed curlew, cannot seem to accustom themselves to the presence of man or to occupy his fields of grain or hay, and thus are on the way to an early extinction in the state.

LIST OF SPECIES

1. *Æchmorphorus occidentalis* (Lawrence). Western Grebe.

DAVIE, 1898, p. 1; a large colony (about 200 nests) breeding at Devils Lake the first of June. JUDD, 1917, p. 5; a common breeder at Freshwater Lake, Ramsey County. BAILEY, 1918, p. 173; fifty-two at one time on Creel Bay, Devils Lake. BENT, 1919, pp. 8-9; east central North Dakota, Devils Lake region: egg dates, forty-six records, May 18 to July 9.

A specimen in the Museum of Zoology Collection was taken at Sweetwater Lake, Ramsey County, July 21, 1900, by Charles L. Cass, and a set of four eggs was taken there by him, May 23, 1900. Another set of four was taken at the lake by E. S. Bryant, May 30, 1906.

This species still breeds in many of the marshy lakes and ponds. At Devils Lake several were seen July 15, 1920, and also in May, 1921.

2. *Colymbus holbœlli* (Reinhardt). Holbœll's Grebe.

JUDD, 1917, p. 5; a common migrant in the prairie region, breeding in ponds and lakes of the Turtle Mountains.

Skins of an adult male, female, and five juvenile birds in the Museum of Zoology Collection were taken at Sweetwater Lake, Ramsey County, June 13, 1900, by Charles L. Cass. The Oological Collection contains a set of six eggs, taken there May 23, 1900. The writer saw a pair with downy young at Sweetwater Lake, July 18, 1920; others at Stump Lake, July 24; at Lake Upsilon, Turtle Mountains, August 2, and several at Devils Lake, August 12. In late June, 1921, many pairs with young were seen in ponds along the Northern Pacific Railroad, and in July along the Great Northern Railroad.

The grebes are of little economic importance, since they live on fish and aquatic insects and plants to such a large extent that their flesh is not good for food.

3. *Colymbus auritus* Linnæus. Horned Grebe.

COUES, 1878, p. 657; the horned grebe was found breeding in the Red River region: on the 20th of June, 1873, a set of four newly-laid eggs was taken from one of the prairie sloughs near Pembina: newly-hatched young were in ponds about the base of Turtle Mountains the latter part of July. JUDD, 1917, p. 5; common migrant; nesting in Turtle Mountains. BENT, 1919, p. 27; egg dates, fourteen records, April 6 to July 7.

Several specimens were noted in the Turtle Mountains, July 30, 1920, and several were seen during July and August at Devils Lake. The species was seen for the first time at Devils Lake in 1921 on May 3.

4. *Colymbus nigricollis californicus* (Heermann). Eared Grebe.

BAIRD, 1858, p. 897; records specimens taken September 17, 1856, at Fort Berthold. HAYDEN, 1863, p. 176; quite rare: two specimens collected in 1856 between Fort Union and Fort Berthold. COUES, 1878, p. 657; breeding abundantly in Turtle Mountains. JUDD, 1917, p. 5; abundant summer resident: breeding in colonies in all ponds of the prairie region that retain water all summer: one colony contained forty odd nests in a small patch of grass about one rod wide by a few rods long. BENT, 1919,

p. 28; quotes Goss, 1883, who found the eared grebe breeding in communities. The first colony found was in a small lake in northern Dakota. There were twenty-five nests on an area of 10 by 20 feet, and the nests were small.

Three males in the Museum of Zoology Collection were taken at Sweetwater Lake, August 17, 1900, by Charles L. Cass. A female was taken at Stump Lake, June, 1897, by Alfred Eastgate. A set of eight eggs was collected June 11, 1900, at Sweetwater Lake, by Cass, and a set of six was taken at Devils Lake, North Dakota, May 28, 1898, by E. S. Bryant.

The species was common at Devils Lake from July 18 to August 19, 1920, and from June 8 to July 20, 1921.

5. *Podilymbus podiceps* (Linnæus). Pied-billed Grebe.

COUES, 1878, p. 658; not as common as the last two species. JUDD, 1917, p. 5; common, breeding in the deeper waters; earliest record April 27, and eggs were found hatching the first week in June. BENT, 1919, p. 40; in the North Dakota sloughs, in 1901, this species was nesting abundantly, in company with canvas-backs, redheads, ruddy ducks, and coots.

It was common on Devils Lake in 1920 and 1921.

6. *Gavia immer* (Brunnich). Loon.

JUDD, 1917, p. 5; common summer resident of the Turtle Mountains; breeding in the larger lakes. BISHOP, 1921, p. 367; describes this as a new subspecies called lesser black-billed loon. Type, adult female, No. 13235. Carpenter Lake, Rolette County, North Dakota, July 13, 1905. L. L. B., collector.

The skin of a male in the Museum of Zoology Collection was taken at Stump Lake, Nelson County, July 19, 1905, by H. A. Shaw. Another immature bird was taken at Lake Upsilon in October, 1919, by Mr. D. R. Ducke. The writer saw individuals at Lake Upsilon from July 30 to August 7, 1920, and again on June 4, 1921.

7. *Larus argentatus* Pontoppidan. Herring Gull.

SCHMIDT, 1904; all sections of the state as a migrant. SCHMIDT, 1920, p. 284; migrant and summer resident. JUDD, 1917, p. 5; a straggler during early spring migrations. FREEMAN, 1919, p. 10; observed in flight April 6 and 8; a transient visitant.

Mr. Alfred Eastgate tells me it is common in migration and breeds at Chase Lake Reserve, Stutsman County.

8. *Larus californicus* Lawrence. California Gull.

SCHMIDT, 1904; nesting in central and eastern North Dakota. JUDD, 1917, p. 5; occasionally seen in summer; one shot in June, 1895, while flying over Rock Lake, Towner County, the first positive record for this region. RIDGWAY, 1919, p. 62?; breeding at Stump and Devils lakes, North Dakota. BENT, 1921, p. 131; one at Devils Lake, North Dakota, April 24.

On July 25, 1920, a few individuals were seen on the Stump Lake Bird Reserve. A large gull was seen on Devils Lake in May, 1921, which may have been the herring gull or this species.

9. *Larus delawarensis* Ord. Ring-billed Gull.

Coues, 1878, p. 655; two specimens shot from a flock on September 12, 1873, near Mouse River, Dakota. Hoffman, 1882, p. 404; noticed daily and usually in pairs; found a poorly mounted specimen in the Great Lodge of the Arikaras, where it was used in one of the ceremonies. Ridgway, 1919, p. 625; breeding at Devils Lake and Stump Lake. Bent, 1921, p. 133; on two islands of Stump Lake Bird Reserve, found breeding in colonies of about a hundred pairs in May and June, 1901. *Ibid.*, p. 140; egg dates, North Dakota, forty-eight records, May 9 to June 22; twenty-four records, May 31 to June 15.

A set of three eggs is in the Oological Collection, Museum of Zoology, which were taken at Devils Lake, North Dakota, May 17, 1892, by James R. Craegue.

A colony of this species bred at the Stump Lake Bird Reserve in 1920. At Devils Lake they were first noted in 1921 on May 10; on May 27 and June 13 a hundred or more were seen. There were a few about Devils Lake all summer, and a colony no doubt nested on a small island near Minnewaukan Bay.

10. *Larus franklini* Richardson. Franklin's Gull.

Coues, 1878, p. 655; a specimen was shot in the Turtle Mountains, July 30, 1873, but no breeding colonies were found. Ridgway, 1919, p. 642; breeding in the Turtle Mountains and at Devils Lake. Bent, 1921, opposite p. 171; a fine photograph of a pair on the nest, taken in North Dakota by H. K. Job.

The skin of a male, collected at Sweetwater Lake, Ramsey County, June 5, 1900, by Charles L. Cass, and a set of two eggs taken there June 8, 1896, by E. S. Bryant, are in the Museum of Zoology Collection.

An abundant summer resident of all the lake regions of the state. It breeds on the islands of both Stump and Devils lakes, where hundreds were seen each day. On July 14, 1920, more than a thousand were assembled on a stony point of Minnewaukan Bay. More than half of these were young of the year. On July 25 hundreds were seen at Stump Lake, and at Lake Irvine, July 27. On August 25 a flock of thousands was seen feeding on the prairie, undoubtedly on grasshoppers.

A small colony occupied Bird Island in Devils Lake in 1921.

This is one of the most important of the North Dakota birds. It is very abundant and annually destroys countless numbers of the most injurious insects—crickets and grasshoppers.

11. *Larus philadelphia* (Ord). Bonaparte's Gull.

Judd, 1917, p. 6; but few stragglers seen during the spring and summer months. Bailey, 1918, p. 27; a few of this species September 1 at Sweetwater Lake, Ramsey County.

It was not seen by the writer in July or August, 1920. At Devils Lake on June 8, 1921, a flock of about two hundred appeared, but all passed on after a few days. Many of these were still in the winter plumage.

12. *Sterna forsteri* Nuttall. Forster's Tern.

Schmidt, 1904; nesting in all three sections of the state. Judd, 1917, p. 6; an occasional specimen taken.

I did not positively identify this species, although many terns were seen daily. Mr. Alfred Eastgate tells me it nested at Kavanah Lake, Ramsey County, in 1898.

13. *Sterna hirundo* Linnæus. Common Tern.

BENT, 1921, p. 133; a large colony at Stump Lake, June 15, 1901; p. 244; egg dates, North Dakota, thirty-six records, May 31 to July 15.

The skins of an adult and two young in the Museum of Zoology Collection were taken at Devils Lake, July 8, 1919, by Crystal Thompson.

This species is an abundant summer resident of the Devils and Stump lakes region and the writer visited large colonies on sandy islands in both lakes. The Devils Lake colony on July 15, 1920, contained only nests with full sets, many of them fresh. Nearly all nests of the Stump Lake colony had young, some able to fly, on July 25.

14. *Hydrochelidon nigra surinamensis* (Gmelin). Black Tern.

COUES, 1878, p. 656; a colony of this species was found breeding at Pembina in June, 1873, and others were seen later at the Mouse River. COUES, 1897, p. 39; June 18, 1843, Audubon saw a black tern which, no doubt, bred there, at Fort Union, Williams County.

A large flock, comprised of hundreds of both adults and young, was seen at Lake Upsilon from July 30 to August 7, 1920. The species was seen at Devils Lake, May 23, 1921. It is an abundant summer resident in all suitable habitats throughout the state and feeds chiefly on small fish and crustaceans.

15. *Phalacrocorax auritus auritus* (Lesson). Double-crested Cormorant.

COUES, 1878, p. 655; observed on the Red River near Pembina late in May. JUDD, 1917, p. 6; tolerably common migrant, no records of its breeding except in Devils and Stump lakes. BAILEY, 1918, p. 175; records a visit to the colony noted above on the bird rocks at Devils Lake. BENT, 1921, p. 133; visited in June, 1901, a colony of about seventy-five pairs on an island in Stump Lake.

A juvenile skin in the Museum of Zoology Collection was taken at the Devils Lake colony on July 15, 1919. This was the last year this species nested on Bird Island. Another juvenile in our collection was taken at the Stump Lake Bird Reserve, June 23, 1919. This was collected by Crystal Thompson, who also collected nests and birds for a habitat group in the Biological Station Museum at Devils Lake.

A set of two eggs collected May 30, 1896, at Sweetwater Lake, Ramsey County, by E. S. Bryant, is in the Museum of Zoology Oological Collection.

It was a rare summer resident as late as 1918, when Crystal Thompson found a small colony nesting on Bird Island. On July 15, 1920, I counted thirty-three old nests and saw one adult bird. This colony left the lake perhaps because of the scarcity of fish and because it was disturbed by campers. On July 25, 1920, the colony on the Bird Reserve at Stump Lake was visited and thirty-five adults and young were counted. The young were nearly

full grown, but many of them were unable to fly, though they swam and dove like seals. This is the same colony visited by Bent in 1901, when it numbered 150 birds.

16. *Pelecanus erythrorhynchos* Gmelin. White Pelican.

Coues, 1878, p. 654; an old female was shot from the steamer as we neared Pembina, and I heard of one or two others shot on the Red River in May. The species was only once again observed, near Mouse River early in September. Coues, 1893, p. 172; October 18, 1804, a pelican was killed, in Emmons County, by the Lewis and Clark Expedition, and on October 19 they saw pelicans in a large pond in the same county. Maximilian records seeing large flocks of pelicans October 11 ,1833, near Fort Union. Thwaites, 1906, p. 199; Fort Union, October 16, 1833, white pelicans passed in large flocks. Judd, 1917, p. 6; common migrant, said to have been found breeding at the east end of Devils Lake. Bailey, 1918, p. 29; records a flock of about sixty on Sweetwater Lake, Ramsey County.

In 1920 an old resident told me that many years ago a few nested at Pelican Bay, Devils Lake. Five were seen July 15, 1920, at Minnewaukan Bay. On May 10, 1921, six came into Creel Bay, and on July 19, forty were observed on a small island in Minnewaukan Bay. Residents of the central part of the state record that a few breed there.

17. *Mergus americanus* Cassin. Merganser.

Judd, 1917, p. 6; sometimes shot by hunters in the fall; none were seen by the writer in the summer.

The Museum of the University of North Dakota has a mounted specimen labelled Bismarck. Mr. J. D. Allen, of Mandan, mounted a male sent in from Bismarck, which was taken March 7, 1921, by W. E. Cleveland.

The merganser occurs in small colonies in timber in the region of Devils Lake. A few males were seen in the Turtle Mountains. Sets of this species were completed from about May 26 to June 1, 1921. In one colony most of the eggs hatched from June 20 to 25.

18. *Mergus serrator* Linnæus. Red-breasted Merganser.

Judd, 1917, p. 6; tolerably common fall migrant.

None were seen alive, but a fine mounted male is in the Williams Collection at Grafton, dated April 7, 1919. There is also one in the University of North Dakota Museum, labelled Devils Lake. There is a mounted male in the Williams Collection taken at Mandan, April 5, 1905, by J. D. Allen.

19. *Lophodytes cucullatus* (Linnæus). Hooded Merganser.

Coues, 1874, p. 585; breeds in North Dakota. Coues, 1878, p. 654; this is the only species of the genus actually observed. Specimens were taken at the Turtle Mountains, August 5 and 7, and at Mouse River, October 1, 1873. Allen, 1875, p. 68; met with near the head of Heart River about July 1, 1874, and also in September, 1874, but not seen elsewhere. Job, 1899, p. 162; in 1890, about the first of June a pair were seen swimming in the Sheyenne River. Bent, 1901, p. 331; one shot in Steele County, June 12, 1901, and six seen in Nelson County, June 15, 1901. Abbott, 1916, p. 3; found one hooded merganser breeding, the only fish duck observed. Judd, 1917, p. 7; saw one flock of young in the Big Coulee. Bailey, 1919, p. 111; saw a female hooded merganser at Sweetwater Lake. Freeman, 1919, p. 10; frequently seen in the Red River, May 13 to October 21.

There is a mounted male without data in the State Agricultural College. The collection of Mrs. Olsen, of Medora, contains a female skin taken on the Little Missouri River by Carl Olsen in 1920. Mr. Russell Reid informs me that on October 15, 1919, a female was shot at Bismarck, and that another was collected at Steele, Kidder County, November 2, 1921, by H. A. Sinish.

20. *Anas platyrhynchos* Linnæus. Mallard.

COUES, 1878, p. 649; flappers about a week old were seen at Pembina, June 20, 1873, on which date adult females and two young were collected. HOFFMAN, 1882, p. 404; saw flocks upon the ponds, but the species was not common at any time in September. COUES, 1893, p. 275; April 16, Lewis and Clark saw many mallards on some small creeks (in Mountrail County). COUES, 1897, p. 112; July 24, 1843, Mrs. Culbertson gave Audubon six young mallards which she had caught by swimming for them in the Missouri River at Fort Union. BENT, 1901, Pl. IV; photograph of nest and ten fresh eggs from Stump Lake, Nelson County, May 31, 1901. JUDD, 1917, p. 7; a set of eggs taken from a stack of wheat, twelve feet from the ground.

There are mounted specimens in all of the state collections and an adult male in the Olsen Collection taken at Medora, October, 1919.

An abundant summer resident, nesting in all suitable habitats. On July 15, 1920, a nest with twelve eggs was found out on the prairie, far from any large body of water.

This species is of much economic importance. It furnishes sport and much valuable food.

21. *Anas rubripes* Brewster. Black Duck.

COUES, 1897, p. 155; August 21, 1843, Audubon saw many old and young black mallards (near the mouth of the Little Missouri). JUDD, 1917, p. 7: Alfred Eastgate, of Stump Lake, and ex-State Auditor H. L. Holmes, of Bathgate, have each a mounted specimen.

The species is of very rare occurrence in North Dakota.

22. *Chaulelasmus streperus* (Linnæus). Gadwall.

COUES, 1878, p. 650; abundant in the Turtle Mountains, August 5, 1873. COUES, 1897, p. 107; July 21, 1843, Audubon saw a single gadwall duck. These birds are found in abundance on the plains where water and rushes are present: p. 155; August 21, saw many young and old gadwalls (near the mouth of the Little Missouri River). BENT, 1901, Pl. V, No. 1, Pl. IV, No. 2, photograph of two nests found at Stump Lake, June 15. REED, 1904, p. 71; records a set of eight eggs collected June 19, 1898, on a low island in Devils Lake, Benson County, North Dakota, by E. S. Rolfe.

A skin in the Museum of Zoology Collection was taken at Minot, October 5, 1910, by Robert P. Stark, and another, an adult male, was taken at Grafton, Walsh County, May 6, 1913, by Henry Williams.

Many broods of young were seen at Devils Lake from July 15 to August 7, 1920, and at Stump Lake, July 25, 1920. It is a common summer resident, nesting in thick grass about the larger ponds and lakes.

23. *Mareca americana* (Gmelin). Baldpate.

COUES, 1878, p. 650: abundant breeder; young, still unable to fly, were found until the middle of September. JOB, 1899, p. 164; on June 27, 1898, found twenty nests of the baldpate on the islands of the Stump Lake Bird Reserve. BENT, 1901,

Pl. V, Fig. 2; Pl. VI, Figs. 1 and 2, p. 336; photograph of three nests at Stump Lake, Nelson County, June 15, 1901. Reed, 1904, p. 72; a set of eggs from Lac aux Morte, Ramsey County, collected by E. S. Bryant. Judd, 1917, p. 7; arriving middle of April.

A not uncommon summer resident, nesting about the ponds and lakes. Many broods of young were seen from July 15 to August 24, 1920, at Devils and Stump lakes.

24. *Nettion carolinense* (Gmelin). Green-winged Teal.

Allen, 1875, p. 67; a few pairs met with during the breeding season and a few small flocks seen in September. Coues, 1878, p. 650; thousands enter the country from the north in August; found no nests, but probably a few bred. Hoffman, 1882, p. 404; frequent occurrence at Fort Berthold, McLean County, September. Judd, 1893, p. 382; May 4, shot a green-winged teal near Cando, Towner County. Job, 1899, p. 163; met the green-winged teal on two occasions in Steele County, May 11, 1898, and on June 20 at Rolla, Rolette County, near the Turtle Mountains, found a female and her brood of eight young. Bent, 1902, p. 1; near Rolla on June 20, 1898, Mr. H. K. Job found a female and eight juveniles. Judd, 1917, p. 7; a few pairs nest each season, but it is a rare breeder. Freeman, 1919, p. 10; fairly common both spring and fall. Bailey, 1920, p. 69; at Island Lake two beautiful green-winged teal were brought in.

I saw very few at Devils Lake from May to August, but at Odessa Narrows there were two females with broods of young on July 23, 1920. One female and a juvenile bird were taken for the record.

25. *Querquedula discors* (Linnæus). Blue-winged Teal.

Coues, 1878, p. 651; very abundant in August. One taken August 22, 1873, Mouse River. Hoffman, 1882, p. 404; rather common at Fort Berthold in September. Coues, 1893, p. 275; April 16, 1805, Lewis and Clark report seeing blue-winged teal in some small creeks, Mountrail County. Coues, 1897, p. 176; August 2, 1843, Bell saw young blue-winged teal in a pond in the first prairie near Fort Union. Bent, 1902, p. 2; found a nest and ten fresh eggs June 12, 1901, on Goose River, Steele County.

There is a male at Mandan taken June 19, 1921, and there are mounted birds in all of the state collections. An adult bird taken August 12, and an immature one taken August 15, 1900, at Sweetwater Lake by Charles L. Cass, are in the Museum of Zoology Collection.

This is the most common breeding duck of North Dakota, nesting all over the state where there is water. A nest with eight fresh eggs was found in tall grass at the side of a road on July 18, 1920, and broods of young were seen on the lakes from June to August.

The species is of much economic importance, because of its great abundance, and also its use for sport and food.

26. *Querquedula cyanoptera* (Vieillot). Cinnamon Teal.

There is an adult male in the Williams Collection at Grafton, taken at Mandan, October 10, 1902, by J. D. Allen. The Agricultural College Collection contains a male taken at Maza, Towner County, in 1901, by W. L. Murray.

This must be considered a straggler or an accidental visitor only.

27. *Spatula clypeata* (Linnæus). Shoveller.

ALLEN, 1875, p. 68; two or three shot near the head of Heart River in September, 1873; no others observed. BENT, 1902, Pl. II, Fig. 1; photograph of nest and eleven eggs taken in Steele County, June 7. REED, 1904, p. 73; records a set of ten eggs, collected on Graham's Island, Devils Lake, by E. S. Bryant, May 28, 1899. JUDD, 1917, p. 7; this species arrives about April 15, nesting in May.

The Museum of Zoology Collection contains three skins taken at Sweetwater Lake by Charles L. Cass: a female June 13, another June 14, and a male June 27, 1900.

This is a very common summer resident, nesting in thick grass not far from water.

28. *Dafila acuta* (Linnæus). Pintail.

COUES, 1878, p. 650; two specimens taken June 20, 1873, at Pembina. BENT, 1902, Pl. II, Fig. 2; photograph of nest and eight eggs found in Steele County, June 10. REED, 1904, p. 73; set of ten eggs from Graham's Island, Devils Lake, June 15, 1900, collected by E. S. Bryant. FREEMAN, 1919, p. 10; a Fargo record of March 17.

Many adults and young were seen at most of the lakes visited. On July 14, 1920, a female with nearly full-grown young was seen at Devils Lake.

This is one of the earliest migrant ducks, and is a common summer resident, nesting in old stubblefields and on the prairie often far from any water. An important economic species.

29. *Aix sponsa* (Linnæus). Wood Duck.

ALLEN, 1875, p. 68; more or less frequent on the Missouri near Fort Abraham Lincoln and Fort Rice, June, 1873, but was not met with elsewhere. BAIRD, 1858, p. 786; one in the National Museum Collection, taken at Heart River, September 22, 1856, by Dr. Hayden. HOFFMAN, 1882, p. 404; common at certain seasons of the year. A single male seen in the possession of an Indian. JOB, 1899, p. 162; noted but once, a male in the Goose River. JUDD, 1917, p. 8; I know of but one specimen taken here. A male in moulting plumage was shot in August on Rock Lake. FREEMAN, 1919, p. 10; uncommon, May 14.

There are two mounted males in the Fargo College Collection with no data; one in the Agricultural College Collection with no data; one in the University of North Dakota from Pembina County; and one in the Williams Collection taken at Grafton, May 8, 1908. This is a very rare duck in North Dakota.

30. *Marila americana* (Eyton). Redhead.

JOB, 1899, p. 165; found redhead eggs in a canvas-back nest. BENT, 1902, Pl. III, Figs. 1 and 2; a nest taken in Steele County, June 10, 1901.

There is a male in the Museum of Zoology Collection taken at Sweetwater Lake, September 14, 1900, by Charles L. Cass. This species was seen frequently on Devils and Stump lakes from May to August. Adults and young were noted in the Turtle Mountains on August 5, 1920. It is not a rare summer resident, nesting only on the larger lakes, in grass and rushes that grow in from one to three feet of water. It is one of the most important ducks for sport and food.

31. *Marila valisinéria* (Wilson). Canvas-back.

COUES, 1878, p. 652; Turtle Mountains in July, 1873. JOB, 1899, p. 164; eleven pairs in one slough on May 21, 1898. BENT, 1902, Pl. IV, Figs. 1 and 2; photographs of nest, taken in Steele County, June 8. BAILEY, 1919, p. 189; saw a female with nine nearly grown young on Sweetwater Lake, Ramsey County.

There is a skin of a female in the Museum of Zoology Collection, taken at Sweetwater Lake, September 14, 1900, by Charles L. Cass, and a set of twenty eggs collected there by him, June 13, 1900. Another female in the Museum of Zoology Collection was taken on May 18, 1913, at Stump Lake, by H. V. Williams.

A few females were seen at Devils Lake in August, 1920, two broods at Sweetwater Lake on July 18, 1920, and others at the Turtle Mountains, August 5 and 7, 1920.

It is rather a rare summer resident, breeding in the grass and rushes of the water holes and coulees. It is considered superior to all other species for food, but has been much over-rated, as it is no better than the redhead.

32. *Marila marila* (Linnæus). Scaup Duck.

JOB, 1899, p. 163; considerable numbers in a large, reedy slough not far from Devils Lake in May and June. JUDD, 1917, p. 8; a common migrant.

The species was seen only rarely at Devils Lake in May, 1921.

33. *Marila affinis* (Eyton). Lesser Scaup Duck.

BENT, 1902, p. 165; the center of its abundance seems to be the Devils Lake region, but it was also found in Nelson and Steele counties. JUDD, 1917, p. 8; first nests found about June 15.

A common summer resident, nesting in all the larger lakes and sloughs. This duck was very common on Devils Lake in May and June, 1921, but the only nest known to me was found near Bluebill Lake, Turtle Mountains, on August 5, 1920. It was in a low meadow, a third of a mile from the water, and contained eight eggs, nearly ready to hatch.

34. *Marila collaris* (Donovan). Ring-necked Duck.

COUES, 1878, p. 651; a specimen was seen in Dawson's Collection. BENT, 1902, p. 167; Mr. Job found a nest of the ring-necked duck in the Turtle Mountains, June 14, 1898. Dr. Bishop flushed two or three ducks from their nests in Nelson County in 1901, which he supposed to be ring-necked ducks, but none were taken. JUDD, 1917, p. 8; one pair seen in Big Coulee. Found breeding in the Turtle Mountains.

There is a mounted male in the Williams Collection taken at Grafton, April 20, 1903.

This is a rare summer resident. A pair was seen at Devils Lake, July 13, 1920.

35. *Clangula clangula americana* Bonaparte. Golden-eye.

BRYANT, 1894, p. 183; a nest of ten eggs and one of thirteen at Devils Lake in 1892. Both nests were in elm trees, one fifteen feet and the other twenty-five feet from the ground. JOB, 1899, p. 164; breeding in small colonies in the timber region of Devils Lake. BENT, 1902, p. 169; on June 1, 1901, found five nests of the American golden-eye in hollow trees at Devils Lake. JUDD, 1917, p. 8; found it breeding in the Turtle Mountains.

This is a rather rare summer resident, nesting in the wooded region about Devils and Stump lakes, and also in the Turtle Mountains. On May 15, 1921, a nest was found in the oak woods on the west side of Creel Bay, and on May 20, 1921, there was another in a cavity of an old oak tree on the Rock Island Military Reservation. This nest was only fifteen feet above the ground and contained seven fresh eggs. On July 2, 1921, an adult female with twelve small young were swimming about on Minnewaukan Bay.

36. *Charitonetta albeola* (Linnæus). Buffle-head.

COUES, 1878, p. 653; among the commonest species after the fall migration, and probably nests in Northern Dakota, as at Turtle Mountains young birds were found in July, 1873.

A pair was seen at Devils Lake, May 10, 1921.

37. *Harelda hyemalis* (Linnæus). Old-squaw.

JUDD, 1917, p. 9; E. S. Bryant claims to have found one dead on the northwest shore of Devils Lake.

The only specimens seen by the writer were a pair in the Agricultural College Museum, taken at Grafton, September 10, 1918, and Mr. Henry Williams reports that they are very rare in North Dakota.

38. *Histrionicus histrionicus* (Linnæus). Harlequin Duck.

OBERHOLSER, 1919, p. 26; records a specimen, which he refers to the Pacific form. *Histrionicus h. pacificus.*

This specimen, a mounted male, taken on the Missouri River at Mandan, September 23, 1912, by J. D. Allen, is in the Williams Collection.

39. *Oidemia americana* (Swainson). Scoter.

This species must be considered as a very rare straggler in North Dakota, and only one record is known to the writer. Mr. Henry Williams reports a male taken at Stump Lake, Nelson County, September 17, 1922.

40. *Oidemia deglandi* Bonaparte. White-winged Scoter.

JOB, 1899, p. 163; June 27, 1898, found eight nests on group of small islands in Stump Lake, which contained fourteen, thirteen, ten, ten, seven, six, one, and no eggs. The last was a new nest ready for eggs. This shows that the bird is a very late breeder. BENT, 1902, p. 171: one nest on June 15, 1901, contained five eggs; another, also on Stump Lake Bird Reserve, on June 22, contained twelve eggs. BAILEY, 1916, p. 55; eight birds at Stump Lake, June 28, 1913. JUDD, 1917, p. 9; straggler to our lakes and ponds; a summer resident on Devils and Stump lakes. BAILEY, 1918, pp. 25 and 26; records two from Sweetwater Lake, Ramsey County, and half-grown young there late in August, 1917.

The species was observed at Devils Lake on August 15, 1920. It was first noted in 1921 on May 25; on May 31 ten birds were seen on the lake. Dr. R. T. Young and the writer found a nest with twelve eggs almost ready to hatch at Stump Lake, July 25, 1920. This nest was built in a thicket of gooseberry bushes on the highest point of one of the islands of the Bird Reserve. The female was very tame and fluttered only a few feet away from the nest.

Devils and Stump lakes seem to be the most southern breeding grounds of the species and the only region in the United States where nests have been found.

41. *Erismatura jamaicensis* (Gmelin). Ruddy Duck.

COUES, 1878, p. 654; common and breeding in suitable localities throughout the region. At the Turtle Mountains it was nesting in numbers in the pools where the young in late July and early August were still unable to fly. Several were taken there, July 28 to 30 and August 7, 1873. JOB, 1899, p. 164; in one slough on May 21, 1898, numerous ruddies in pairs were swimming among the reeds. BENT, 1902, p. 172; found five nests of the ruddy duck in two sloughs in Steele County in June, 1901. JUDD, 1917, p. 9; very common; breed on all the big lakes, where they arrive the latter part of April.

There is a skin of an adult female in the Museum of Zoology Collection taken June 25, 1900, at Sweetwater Lake, by Charles L. Cass, and there are mounted specimens in several bird collections in North Dakota.

Several individuals were seen at Stump Lake, July 24 and 25, 1920, and a few at Lake Upsilon, Turtle Mountains, July 30, 1920. They were noted at Devils Lake from May 5 to July 19, 1921.

42. *Chen hyperboreus hyperboreus* (Pallas). Snow Goose.

COUES, 1878, p. 649; abundant during migrations. In the fall none were seen until October. JUDD, 1891, p. 169; snow geese were most abundant after October 17, 1890, near Cando. COUES, 1893, p. 263; Lewis and Clark reported that a great number of brant passed up the river, April 9, 1805, some of which were perfectly white except the large wing feathers. (Coues says these were snow geese.) JUDD, 1917, p. 9; flocks of thousands are a common sight from the last week in March to May 1 and a few small flocks stay until June 1. The big flight in the fall occurs about October 10, but some stay until the lakes freeze over. BAILEY, 1920, p. 106; saw a snow goose the last of September at Sweetwater Lake.

I did not see this species alive. There is a mounted specimen in the University of North Dakota Museum, taken at Devils Lake, and also one at the Agricultural College. Another specimen was taken at Bismarck, November 11, 1921, by E. J. Erbe.

43. *Chen hyperboreus nivalis* (J. R. Forster). Greater Snow Goose.

JUDD, 1917, p. 9; specimens whose size would apply to this subspecies are shot at all times from the large flocks of the lesser snow goose.

There is a specimen without data in the University of North Dakota Museum. Another, taken at Grafton, April 13, 1907, was seen in the Williams Collection.

44. *Chen cærulescens* (Linnæus). Blue Goose.

JUDD, 1893, p. 382; on May 4, shot a blue goose near Cando, Towner County. JUDD, 1917, p. 9; rare in migration; one to four are usually seen in nearly every large flock of snow geese. FREEMAN, 1919, p. 11; observed fairly often; date March 24.

There is a specimen in the Agricultural College Museum collected at Grafton, October 27, 1913, by H. V. Williams. Another was taken from a large flock at Grafton, March 30, 1906, by William Williams.

45. *Chen rossi* (Cassin). Ross's Goose.

JUDD, 1917, p. 9; one shot April 22, 1893. Heard of others being seen, but none came to notice.

I have been able to find no other record of this species in the state.

46. *Anser albifrons gambeli* Hartlaub. White-fronted Goose.

JUDD, 1891, p. 169; some shot near Cando, October, 1890.

There is a mounted bird in the Williams Collection which was taken at Grafton, April 4, 1906. None were observed during the field work.

47. *Branta canadensis canadensis* (Linnæus). Canada Goose.

COUES, 1878, p. 649; saw several broods of goslings on the Missouri River in June, 1874. HOFFMAN, 1882, p. 404; immense numbers were observed throughout September at Fort Berthold, McLean County. COUES, 1893, pp. 192, 250, 269, 270; Lewis and Clark reported large flocks of geese and brant passing south at Fort Mandan, November 10, 1894. On March 31, 1805, several flocks of geese, the first ones seen, flew up. By April 10 the geese were feeding near Fort Berthold. On April 13 a lake and adjoining creek flowing into the river were named Goose Lake and Goose Creek, because of the large number of geese feeding on them. They built their nests in the tops of the lofty cottonwood trees. Coues says these were Canada geese, and he confirmed the above statement when he passed this point in the river in 1874. COUES, 1897, p. 7; Audubon saw geese and goslings near the mouth of the Cannonball River, Morton County, June 5, 1843. BENT, 1902, pp. 173, 174; reports quite a number of Canada geese breeding in North Dakota. Found one nest on June 2, 1901, in a large slough in Nelson County; another which the young had left on June 10, in Steel County. REED, 1904, p. 84; records a set of five eggs from Ellingers Lake, May 18, 1896, collected by Edwin S. Bryant. JUDD, 1917, p. 9; common breeder, noted as early as March 8 and as late as November 20.

At present this might be considered a rare breeder in the state. Captain Lonnevik, of the Rock Island Military Reservation, says that it is still nesting at Sweetwater Lake. On August 12, 1920, a family of five were seen on Devils Lake. A small flock flew over Devils Lake May 4, 1921.

48. *Branta canadensis hutchinsi* (Richardson). Hutchins's Goose.

JUDD, 1892, p. 314; saw this species near Cando. JUDD, 1917, p. 9; common migrants, which usually feed by themselves in flocks of ten to fifteen.

A mounted specimen taken at Sweetwater Lake, Ramsey County, October 10, 1915, is in the Williams Collection.

The species seems to be rather rare in the state.

49. *Branta canadensis minima* Ridgway. Cackling Goose.

JUDD, 1917, p. 9; two specimens shot in 1894 and one in 1895, by Dr. L. B. Bishop, were assigned to this subspecies.

A mounted specimen is in the Museum of Zoology Collection, labelled Sweetwater Lake, October 10, 1915.

50. *Branta nigricans* (Lawrence). Black Brant.

The species has not been recorded in lists of North Dakota birds. The only specimen seen was an immature bird in the Williams Collection. It was taken at Lakota, Nelson County, October 26, 1917.

51. *Olor columbianus* (Ord). Whistling Swan.

Coues, 1897, p. 5; Audubon says on June 5, 1843, he saw two swans light on the prairie near the mouth of the Cannonball River: p. 19; saw two on June 8 near Mandan: p. 154; on August 17 saw twenty-two swans near Fort Union. Judd, 1917, p. 9; one specimen was brought in in the fall of 1894.

There is a mounted specimen in the Biological Station Museum taken at Stump Lake by Alfred Eastgate, and one in the University of North Dakota Museum taken at Devils Lake. According to residents, they occur during migration at the lakes. Mr. Allen, of Mandan, mounted two birds from Fullerton, Dickey County, taken October 20, 1921, by George Paulson.

52. *Olor buccinator* (Richardson). Trumpeter Swan.

Hayden, 1863, p. 175; seen at certain seasons of the year in large flocks throughout the northwest. A few breed in the valley of the Yellowstone. Coues, 1878, p. 648; observed on a few occasions in Dakota late in September and the first half of October during the migration. It appears to pass chiefly at night. Judd, 1893, p. 382; not uncommon in migration. Judd, 1917, p. 11; tolerably common migrant as early as April 13 and the latter half of October. They seldom fly in greater numbers than four to six.

In the museum at the University of North Dakota is a specimen labelled Stump Lake, North Dakota, A. J. Hutchins. This bird stood by the side of a whistling swan and was much larger and taller; its wing measured twenty-six and a half inches and it had twenty-two tail feathers, while the other swans in the collection had each twenty tail feathers and wings from twenty to twenty-one and a half inches. A trumpeter swan (No. 17779) in the collection of H. K. Coale is labelled North Dakota, November, 1891.[4] Mr. Alfred Eastgate told the writer that it bred at Rock Lake, Towner County, in 1895. No live birds were seen.

53. *Plegadis guarauna* (Linnæus). White-faced Glossy Ibis.

The only records found are a specimen in the Museum of Zoology, labelled North Dakota, 1882, and a mounted specimen in the Agricultural College Museum, taken at Mandan by J. D. Allen in 1912. Mr. Williams told me he saw a bird of this species at Amidon, Slope County, in May, 1920.

54. *Mycteria americana* Linnæus. Wood Ibis.

Mr. Williams, of Grafton, mounted a bird of this species in the spring of 1900. It was taken in a big slough east of Glasston, Pembina County.

55. *Botaurus lentiginosus* (Montagu). Bittern.

Coues, 1878, p. 646; rather common on Mouse River in September, 1873. One was taken on September 2, another September 8. Judd, 1917, p. 11; very common.

Small numbers were seen in nearly all of the regions visited. There is a specimen in the Museum of Zoology labelled Devils Lake, 1900, Charles L. Cass.

56. *Ixobrychus exilis* (Gmelin). Least Bittern.

Judd, 1917, p. 11; two seen by Mr. Bishop at Rock Lake, June 20, 1895. Also reported from Devils Lake.

[4] *Auk*, 1915, Vol. XXXII, pp. 84-85.

No living specimens were seen, but there is a mounted bird in the Agricultural College Museum at Fargo with no data.

Mr. Williams, of Grafton, says it is very rare and he has seen but one, near Glasston, Pembina County, during the past twenty-five years.

57. *Ixobrychus neoxenus* (Cory). Cory's Least Bittern.

Mr. Alfred Eastgate is authority for a record of this form, at Graham's Island, Devils Lake, 1904.

58. *Ardea herodias herodias* Linnæus. Great Blue Heron.

COUES, 1878, p. 646; observed during passage down the Red River in 1873. ALLEN, 1875, p. 67; a single specimen seen on Heart River, the only representative of the family noted on the journey. HOFFMAN, 1882, p. 403; singly or in pairs this species occurs along the Missouri River during the early portion of September; none noticed after the tenth. JUDD, 1917, p. 11; rare; only now and then seen in recent years; breeds in the Turtle Mountains.

The species seems to be quite uncommon in the state. There is a mounted specimen in the Biological Station Museum probably taken near Devils Lake. The Williams Collection contains one labelled Grafton, September 30, 1920. One in the Olsen Collection was collected at Medora in the summer of 1920. On August 2 and August 4, 1920, a family of four were seen at Lake Upsilon, Turtle Mountains.

59. *Nycticorax nycticorax naevius* (Boddaert). Black-crowned Night Heron.

COUES, 1878, p. 646; one individual seen during the passage down the Red River, in 1873. BRYANT, 1894, p. 183; colony at Lake Alice, Ramsey County, in the spring of 1892. JUDD, 1917, p. 11; tolerably common, breed in colonies in trees about Lake Alice, also in heavy grass sloughs and thick bushes at Rock Lake. Earliest arrivals, April 13.

A set of six eggs in the Museum of Zoology Collection was taken at Sweetwater Lake, Ramsey County, on May 31, 1896, by E. S. Bryant.

They were not rare about Twin Lakes, Ramsey County, August 18, 1920, and later were seen at Devils Lake and a small mud pond on the Rock Island Military Reservation.

60. *Grus americana* (Linnæus). Whooping Crane.

COUES, 1878, p. 646; white cranes were frequently observed in the Mouse River country in August, September, and October, but always at a distance; there is no reason to doubt that they breed there. ABBOTT, 1880, p. 984; a flock of three were met July 6, 1879, near Pembina. HOFFMAN, 1882, p. 404; frequently seen flying northward about the middle of September at Fort Berthold, McLean County, North Dakota. JUDD, 1891, p. 169; saw white cranes October 5, 1890, near Cando. COUES, 1893, p. 267; April 11, 1805, Lewis and Clark record seeing some cranes, the largest bird of that kind common to the Missouri and Mississippi, perfectly white, except the large feathers on the first joint of the wing, which are black, just above the mouth of the Little Missouri River in McLean County. THWAITES, 1906, p. 183; on September 22, 1833, Maximilian saw a small flock of whooping cranes near Fort Union. JUDD, 1917, p. 11; tolerably common migrant, probably nests in the Turtle Mountains; earliest arrivals, April 13.

Mr. Russell Reid, of Bismarck, reports one shot near Leroy, Pembina County, fall of 1919; two small flocks seen at Bismark, one September 16, 1920, and the other April 8, 1922.

There are several mounted birds in the state; one in the University of North Dakota Collection, taken in Cavalier County; one in the Williams Collection, taken at Lakota, Nelson County, in 1919; two in the Agricultural College Collection, with no data; one in the collection of Clarence Hale, shot at Glasston, Pembina County, in 1899. Mr. Williams furnished the data for a specimen taken by W. R. Ross at Calvin, Cavalier County, April 20, 1907; one at Sherwood, Renville County, by A. J. Clark, September 19, 1908, and one at Hamilton, Pembina County, by D. D. Warren, April 12, 1912.

Mr. Alfred Eastgate tells me that the species bred commonly until 1908 in Nelson County.

A flock of seven whooping cranes was seen from the car window, standing at the edge of a small pond near the track, just east of Medina, Stutsman County, on June 24, 1921. They flew up as the train passed, making a great spread of black and white plumage.

61. *Grus canadensis* (Linnæus). Little Brown Crane.

ALLEN, 1875, p. 67; large flock seen at the crossing of the Little Missouri, September 15, 1873, circling high in the air over the camp; the only time the species was observed. (Allen noted this under the species *canadensis*, but these birds may have been *mexicana*.) JUDD, 1917, p. 11; one pair shot out of a flock of ten or twelve, April 18, 1895, now in the collection of H. L. Bigelow, Boston, Massachusetts.

There is a specimen in the Williams Collection taken near Grafton, September 30, 1920. In the Agricultural College Museum is an individual from Custer Flats, 1912, and in the Fargo College Collection is one from Goodrich, Sheridan County, 1909.

62. *Grus mexicana* (Müller). Sandhill Crane.

CULBERTSON, 1851, p. 118; "June 13 one of the pilots brought me a very young sandhill crane, which I put in alcohol, and I intend preserving the skeleton of a larger one, which was not in a condition to skin." (Missouri River, between Forts Clark and Berthold.) COUES, 1878, p. 646; commonly observed after leaving Pembina; it appears to breed over the whole region in prairie country. HOFFMAN, 1882, p. 404; more frequently seen than the whooping crane. JUDD, 1891, p. 169; saw sandhill cranes near Cando, October 5, 1890. COUES, 1897, p. 9; Audubon saw a young sandhill crane near Heart River, Morton County, on June 6, 1843; p. 95; on July 16 there was a sandhill crane about two years old in a grassy bottom near Fort Union. THWAITES, 1905, p. 199; October 16, 1833, Maximilian records large flocks of cranes passing the boat near Fort Union. JUDD, 1917, p. 11; common, breeds in Towner County in isolated sloughs that contain more or less water. The fall flights are often very large and in some localities they do some damage to grain, earliest migrants noted April 6 and a full set of eggs June 9. BAILEY, 1920, p. 67; the most notable bird found in the Turtle Mountains was a sandhill crane.

This species was not seen alive. There are mounted specimens in the state collections, and J. D. Allen, of Mandan, mounted one from Steele, Kidder County, taken October 6, 1921, by M. Hogue. Mr. Russell Reid says it does not seem to be rare during migrations: on April 16, 1921, eight large flocks were seen, about five hundred birds in all. Residents told me there were a few still breeding in the big sloughs, that more were seen in migration, but they are no longer a very common species. Formerly

they were of some economic importance, furnishing sport and food for hunters.

63. *Rallus elegans* Audubon. King Rail.

JUDD, 1917, p. 11; Bryant claims to have seen one at Freshwater Lake.

There is a specimen without data in the Agricultural College Museum. This was the only bird seen.

64. *Rallus virginianus* Linnæus. Virginia Rail.

ALLEN, 1875, p. 67; met with once or twice in June, 1873, near the Heart River. BENT, 1901, p. 330; Virginia rails nested in short grass about the edges of sloughs. JUDD, 1917, p. 11; not common and noted only in fall migrations. FREEMAN, 1919, p. 11; has photographs of individuals found in Island Park at Fargo.

The species was not seen in the field. There is a specimen in the Agricultural College Collection taken at Grafton, June 3, 1910, by Henry Williams.

65. *Porzana carolina* (Linnæus). Sora.

COUES, 1878, p. 647; observed during the migration in September along the Mouse River. BENT, 1901, p. 330; nested in short grass about edges of sloughs. JUDD, 1917, p. 11; very common, nearly every slough containing water in June has a pair or more nesting. BAILEY, 1918, p. 67; common in the sloughs about Sweetwater Lake. FREEMAN, 1919, p. 11; very common, May 14.

The species is more often heard than seen. One was observed at Dry Lake, Ramsey County, July 18, 1920, and one at Stump Lake, July 25, 1920.

66. *Coturnicops noveboracensis* (Gmelin). Yellow Rail.

REED, 1904, p. 105; set of ten eggs collected June 4, 1901, in Benson County, by Rev. P. B. Peabody. ABBOTT, 1916, No. 94, p. 4; "Resting against a boulder, reveling in the prolonged sunset, a metallic 'click' penetrates the verdure directly in front. The author has several imitators. The birds are ventriloquists and you can't disturb nor dislodge them. Take two stones the size of black walnuts and bring them together squarely. This will convey to you a proper interpretation of the notes. They issue from throats of the little yellow rail, the feathered mouse of the northern swales." ABBOTT, 1919, p. 97; visited the yellow rail coulee in the Choctaw Basin, Benson County, North Dakota.

The Rev. P. B. Peabody, of Blue Rapids, Kansas, in a letter of November 16, 1921, says yellow rails are found rather commonly, breeding in the Sheyenne coulees of Benson County, North Dakota, in late May and early June. Eight to fifteen eggs are usual; never, so far as known, more. The nests are usually found in fine grass where water is one to four inches deep. The bird is abundant locally, and rather surpasses, in numbers, both the other rails, *Rallus virginianus* and *Porzana carolina*, occurring in the same area.

67. *Fulica americana* Gmelin. Coot.

COUES, 1878, p. 647; extremely abundant from the Red River to the Rocky Mountains. HOFFMAN, 1882, p. 404; frequently noticed along the Missouri River between Bismarck and Fort Berthold until September 20, 1881. JUDD, 1917, p. 12; breeds in numbers in all large sloughs and many of the smaller ones. They are very prolific layers and replace stolen sets; at least three thousand eggs were taken by Indians around Rock Lake in the early summer of 1895.

There are two sets of eggs in the Museum of Zoology Collection; one lot of eleven taken at Larimore, Grand Forks County, June 10, 1896, by Alfred Eastgate, and another of six collected at Sweetwater Lake, Ramsey County, May 23, 1900, by E. S. Bryant.

68. *Lobipes lobatus* (Linnæus). Northern Phalarope.

JUDD, 1917, p. 12; tolerably common during spring migration, not noted in the fall. FREEMAN, 1919, p. 11; seen once on September 2.

At Devils Lake this species was one of the earliest migrants from the north in 1920. On July 15 a flock of nearly one hundred were feeding on the water and several were taken for records. In 1921 a few were seen on May 17, and the number gradually increased until May 25, when a big wave of them came in, and I estimated that there were a thousand or more in Creel Bay alone. Thousands more arrived each day until, on May 30, there must have been from eight to ten thousand on the bay. They were very tame and fed all around the boat on the numerous aquatic insects. Most of them left on June 2 and 3. On July 19 hundreds were on the lake again, the first arrivals from their summer homes in the north.

69. *Steganopus tricolor* Vieillot. Wilson's Phalarope.

COUES, 1878, p. 636; breeds throughout the country from the Red River to the Rocky Mountains. At Pembina breeds about reedy pools and prairie sloughs in June. REED, 1904, p. 100, a set of eggs from Larimore, Grand Forks County, May 30, 1897, collected by T. F. Eastgate. JUDD, 1917, p. 12; breeding in numbers around Rock Lake, Towner County. Nests were not far from the water on level, moist ground in a thick growth of grass. First arrivals were noted May 1. BAILEY, 1918, p. 65; photograph of nest and bird at Sweetwater Lake, Ramsey County, 1917.

This is a common summer resident, breeding in suitable localities. The earliest spring arrival was May 26, 1921. During August, 1920, many flocks came and fed in the mud flats of Creel Bay, Devils Lake.

70. *Recurvirostra americana* Gmelin. Avocet.

COUES, 1878, p. 635; not observed in the Red River region. S. C. C., p. 415; quite common, Bismarck, April 18, 1887. THWAITES, 1905, p. 186; on September 28, 1833, near Fort Union, Maximilian records seeing the avocet with its strange upturned bill. ABBOTT, 1916, p. 2; opposite this page is a photograph of a set of eggs *in situ* and another of the same showing young just hatched. These were evidently taken in North Dakota, but no data is given. JUDD, 1917, p. 12; a rare species, but undoubtedly breeds. A female taken May 15, 1895, by Dr. Bishop contained an egg fully formed.

The species was not seen in the field. Mr. Reid reports that it is frequent on some of the larger alkali lakes and sloughs northeast of Bismarck, and was noted at Chase Lake, Stutsman County, and was quite common at Lake Isabel, Kidder County, August 7, 1921. Mr. Alfred Eastgate tells me he saw avocets near Larimore in the summer of 1921. There is a mounted female in the Agricultural College Collection taken at Kenmare, Ward County, May 4, 1913. Two others, taken at Minot by W. S. Mummery, and one from the Turtle Mountains, October 5, 1917, by J. Kusler,

are also in that collection. The Olsen Collection contains a specimen taken in April, 1921, by Carl Olsen at the Little Missouri River. Mr. Allen, of Mandan, has mounted a bird taken at Dawson, Kidder County, October 3, 1921, and another from Windsor, Stutsman County, August 16, 1921.

71. *Himantopus mexicanus* (Müller). Black-necked Stilt.

The only record we have of this species is of a bird seen by Mr. Williams at Grafton during the spring migration of 1905.

72. *Philohela minor* (Gmelin). Woodcock.

COUES, 1874, p. 473; a woodcock shot at Fort Rice, Morton County.

A rare migrant or straggler in North Dakota. A resident hunter reported that he secured three from a flight in October, 1920, near St. Johns, Rolette County.

73. *Gallinago delicata* (Ord). Wilson's Snipe.

COUES, 1878, p. 638; abundant in the Mouse River region in September, 1873, when several specimens were taken the 16th and 27th. JUDD, 1917, p. 12; moderately common migrant, very common from July to October, 1893, in wet, grassy sloughs. Since found breeding in Turtle Mountains in some numbers. FREEMAN, 1919, p. 11; fairly common migrant, May 7.

I did not find this species in the field, but saw a mounted bird in the Williams Collection at Grafton, taken there May 3, 1904, by Henry Williams.

74. *Macrorhamphus griseus scolopaceus* (Say). Long-billed Dowitcher.

COUES, 1878, p. 638; during the fall migration in September the birds were numerous in the Mouse River region. JUDD, 1917, p. 12; moderately common, irregular migrant in late summer.

There is a mounted bird in the Williams Collection taken at Stump Lake, May 9, 1913, by Henry Williams.

On May 31, 1921, I saw a bird of this species in a large flock of sandpipers on a sandy point on Creel Bay, Devils Lake. Again, on July 24, a couple were seen on a small lake near Grafton in company with sanderling and lesser yellowlegs.

75. *Micropalama himantopus* (Bonaparte). Stilt Sandpiper.

JUDD, 1917, p. 12; a small flock seen May 27, 1895, and another flock or two the last week in July, migrating south.

There is a mounted specimen in the Agricultural College Collection taken at Stump Lake, May 9, 1913, by Henry Williams. A skin in the Museum of Zoology Collection was taken at Sweetwater Lake, August 13, 1900, by Charles L. Cass.

Considering the rarity of this species, I was fortunate in finding a flock of about thirty on July 15, 1920. These were feeding on the mud shore of Minnewaukan Bay, Devils Lake, and all were still in the dark barred breeding plumage. A few others were seen at Bluebill Lake in the Turtle Mountains on August 1, 1920. On May 31, 1921, a flock of ten or a dozen in the

breeding plumage were noted on the shore of Creel Bay, Devils Lake; these were the only ones seen in the spring migration.

76. *Tringa canutus* Linnæus. Knot.

The only knots known by the writer to have been taken in North Dakota are a bird in the Williams Collection, collected at Stump Lake, May 19, 1913, and another in the Agricultural College Collection, taken at Grafton, May 30, 1919, by Henry Williams.

77. *Pisobia maculata* Vieillot. Pectoral Sandpiper.

Coues, 1878, p. 640; common in the fall migration. First seen the latter part of July on the pools at the base of Turtle Mountains. Two specimens were taken July 28, 1873. Judd, 1917, p. 12; abundant migrant, arriving the last week in April.

At Turtle Mountains this species was common from July 30 to August 7, 1920, in all the ponds and lakes visited. In the spring my first record was on May 27, 1921, when ten were seen on the beach of Devils Lake. In the fall migration it was first seen July 21, 1920, at a mud pond in the Rock Island Military Reservation.

78. *Pisobia fuscicollis* (Vieillot). White-rumped Sandpiper.

Judd, 1917, p. 12; most abundant migrant of the sandpiper family, first seen April 19.

There is a mounted specimen in the Agricultural College, taken at Kenmare, Ward County, June 1, 1913, by H. E. Peck.

The species was observed in the field but once, on July 2, 1921, on the shore of Minnewaukan Bay. The only two seen were taken. The species is apparently becoming quite rare in the state.

79. *Pisobia bairdi* (Coues). Baird's Sandpiper.

Coues, 1878, p. 640; during the fall migration in the month of August, one of the most abundant sandpipers in Dakota. Small flocks were found along the Mouse River, where specimens were taken August 21-30, 1873. Judd, 1917, p. 12; common migrant; arrives third week in April.

The first spring record was May 9, 1921, at Devils Lake, and more were recorded daily until May 23, when more than two hundred were seen. These gradually disappeared and by June 10 all had gone. The first fall record was July 14, 1920. After this date it became common at Devils Lake and was seen frequently at several other lakes and ponds. In 1921 ten were seen at Devils Lake on July 18, after which it became very common.

80. *Pisobia minutilla* (Vieillot). Least Sandpiper.

Coues, 1878, p. 640; taken July 30, 1873, at Turtle Mountains. Judd, 1917, p. 13; fairly abundant migrant, first arrivals May 2, staying three or four weeks.

This species was seen first on May 10, 1921, at Devils Lake, and by May 28 two hundred or more were there. They had all gone by June 3. On the return migration a few were noted on July 2 at Devils Lake, and on July 27 they were quite abundant.

81. *Pelidna alpina sakhalina* (Vieillot). Red-backed Sandpiper.

JUDD, 1917, p. 13; fairly common migrant in 1895; first arrivals May 2.

There is a specimen in the Williams Collection, taken at Grafton, May 16, 1910, by Mr. Henry Williams.

In 1920 none were noted in July and August, but one was taken and another seen July 2, 1921, on the shore of Minnewaukan Bay. Seven of this species were on the beach at Creel Bay, May 7, two on May 16, and three on May 18, 1921.

82. *Ereunetes pusillus* (Linnæus). Semipalmated Sandpiper.

COUES, 1878, p. 639; abundant species noted at various points during the month of August, one taken at Mouse River, August 10, 1873. HOFFMAN, 1882, p. 403; not common near Fort Berthold, McLean County. JUDD, 1917, p. 13; equals the least sandpiper in numbers.

The species was very common after May 9, 1921, at Devils Lake. As late as May 31, a hundred or more were still there. Two were seen on the return migration, July 18, 1921. On July 21, 1920, large flocks were seen at a mud pond on the Rock Island Military Reservation.

83. *Ereunetes mauri* Cabanis. Western Sandpiper.

JUDD, 1917, p. 13; found with the semipalmated sandpipers, which they closely resemble.

On May 31, 1921, a single western sandpiper was taken from a large flock of sandpipers feeding on the beach at Devils Lake. While this was the only one identified, the species no doubt occurs rarely during the migrations.

84. *Calidris leucophæa* (Pallas). Sanderling.

JUDD, 1917, p. 13; not common, first date May 28.

The sanderling seems to be a rather common species in the Devils and Stump lakes region, especially during the fall migration. In 1920 the first were seen at Stump Lake July 24, but it soon became abundant on all the lake beaches and by August 24 it was one of the most common waders at Devils Lake. The first record for 1921 is May 26, at Devils Lake, when ten were noted. On May 31 over two hundred, and on June 10 thirty were seen there.

85. *Limosa fedoa* (Linnæus). Marbled Godwit.

BAIRD, 1858, p. 741; records the specimen mentioned below, No. 5450, as collected by Dr. Hayden, but does not give the date. However, it is listed in the Catalogue of the Trowbridge Collection and has the following data: "*Limosa fedoa*, Ord. Marbled Godwit. Male. Ft. Union, Nebraska (Dakota), July. Lt. Warren; Dr. Hayden. (5450.)" (The specimen is in the Museum of Zoology Collection.) HAYDEN, 1863, p. 175; not common; took one at Fort Union. COUES, 1878, p. 641; a female was taken June 20, 1873, at Pembina, where they were probably breeding. COUES, 1897, p. 176; August 2, 1843, Bell saw several godwits near Fort Union. REED, 1904, p. 119; a set of four eggs taken June 10, 1895, at Devils Lake by W. F. Hill. BENT, 1907, p. 160; saw about twenty-six godwits in Steele County, June 13, 1901. At

Stump Lake, Nelson County, Dr. Louis Bishop noted a flock of about a hundred July 28, 1902, and on July 26, 1905, saw flocks of about forty adults and young. Judd, 1917, p. 13; a few pair nested in Towner County.

Mr. Reid reports that a few breed in sloughs south of McKenzie, Burleigh County, each year. Noted June 9, 1921.

In 1920 godwits were first seen at a mud pond in the Rock Island Military Reservation on July 21. They were seen at Stump Lake, July 24, and flocks of eight to twelve became common in August at Devils Lake. They fed on the lake beaches as late as August 24, when all were in winter plumage. Two were seen on the shore of Creel Bay, Devils Lake, on May 11, 1921. It was not noted again until June 3, when a pair were found in a wet marsh near Cando, where they were breeding.

86. *Limosa hæmastica* (Linnæus). Hudsonian Godwit.

Judd, 1917, p. 13; a fairly common migrant in 1895, first seen April 24.

There is a specimen in breeding plumage in the Williams Collection, taken at Grafton, May 7, 1911. An adult female, taken May 15, 1913, at Stump Lake, Nelson County, by Henry V. Williams, is now in the Museum of Zoology Collection. The species seems to be rare in the state. Coues did not see it in 1873, and I saw none during 1920 and 1921.

87. *Totanus melanoleucus* (Gmelin). Greater Yellow-legs.

Baird, 1858, p. 732; one taken at Fort Berthold, McLean County, in 1856. Allen, 1875, p. 66; seen a few times on the Heart River in September, 1873. Coues, 1878, p. 642; not observed until the last week in July; very abundant in August and September throughout the region. Specimens were taken on Mouse River, August 19, 23, 24, 25, 1873. Judd, 1917, p. 13; fairly common migrant, first arrivals third week in April. Freeman, 1919, p. 12; fairly common, May 5.

Only one was seen. This was feeding on a mud flat near the Missouri River, at Williston, July 16, 1921. There is a mounted specimen in the Williams Collection taken at Grafton, April 30, 1909, and another, taken there April 19, 1914.

88. *Totanus flavipes* (Gmelin). Yellow-legs.

Coues, 1878, p. 643; very abundant in the Turtle Mountains and Mouse River region, August 5, 10, 22, 25, 30. Judd, 1917, p. 13; common migrant, arrives in flocks about April 20.

This was one of the most common waders present on May 3, 1921, at Devils Lake, where it lingered until May 17. In 1920 it was first seen July 13 at Devils Lake, where flocks of two hundred soon became common. At Lake Upsilon, Turtle Mountains, sixty were counted in a flock August 4, 1920.

89. *Helodromas solitarius solitarius* (Wilson). Solitary Sandpiper.

Baird, 1858, p. 734; one taken at Fort Union, July, 1856, by Dr. Hayden. Coues, 1878, p. 643; occurs in abundance on all pools and water courses of the region during the autumnal migration, and there is reason to believe that some may breed in this latitude. Specimens taken at the Turtle Mountains, August 5, 1873, and Mouse River, August 22, 23, 1873.

Adults and young were seen at Devils Lake on July 30, 1920. The species was present and seemingly at home at Lake Upsilon, Turtle Mountains, on June 5, 1921. It is evident that it breeds in the lake and mountain regions at least.

90. *Catoptrophorus semipalmatus inornatus* (Brewster). Western Willet.

COUES, 1878, pp. 641-642; Red River to Rocky Mountains. Breeds in this region. HOFFMAN, 1882, p. 404; frequent along the sand-bars of the Missouri. JUDD, 1917, p. 13; common summer resident, arrives first week in May. BAILEY, 1918, pp. 113-114; family of nearly grown young near Sweetwater Lake, Ramsey County.

There is a male skin in the Museum of Zoology Collection taken in Ramsey County, June 5, 1900, by Charles L. Cass.

Mr. Alfred Eastgate found a nest with eggs in a wet meadow near Bottineau in June, 1920. On July 23, 1920, several adults with young were seen at Odessa Narrows. The young were mostly well grown. Fifteen birds were seen on July 27, 1920, at Devils Lake, and it was common there until August 20. In 1921 the species was first seen on May 12 at Devils Lake, and a few individuals fed on the beaches all of May and June. A pair were seen in a wet marsh near Cando, June 3, 1921.

91. *Bartramia longicauda* (Bechstein). Upland Plover.

BAIRD, 1854, p. 738; taken at Fort Union, July, 1855. ALLEN, 1875, p. 67; very common on the prairies east of the Yellowstone, where it outnumbers all the other Grallae together. COUES, 1878, p. 644; extremely abundant over all the prairie of the Red River region, where they breed in June. Twenty-six specimens taken at Pembina, June 4 to June 28, 1873, one at the Turtle Mountains, July 23, and one at Mouse River, August 19, 1873. ABBOTT, 1880, p. 985; says it is one of the most common birds of the prairie. HOFFMAN, 1882, p. 404; rather common during first three weeks of September. JUDD, 1893, p. 382; shot in numbers. BENT, 1901, p. 329; scattered about in pairs nesting in short grass. REED, 1904, p. 123; set of eggs collected June 10, 1897, at Stump Lake, Nelson County, by Alfred Eastgate. JUDD, 1917, p. 13; abundant summer resident formerly, but in 1910 the species was uncommon, and now only pairs are seen, and they are growing less in numbers very speedily. BAILEY, 1918, p. 112; a few on a strip of prairie near Sweetwater Lake.

A mounted specimen is in the Williams Collection, taken June 6, 1909, at Grafton, and there is a pair in the Museum of Zoology Collection taken at Grafton, June 10, 1914, by Henry Williams. Mr. Williams tells me that on the night of September 12, 1921, he heard a flock passing south overhead.

I was surprised at the scarcity of this species. In 1920 I saw but four in all the region worked, and in 1921 but three, on June 4, near St. Johns. It is rapidly becoming more rare.

92. *Tryngites subruficollis* (Vieillot). Buff-breasted Sandpiper.

JUDD, 1917, p. 13; a few single birds and one large flock were seen the last week in May, 1895. FREEMAN, 1919, p. 12; one record, September 21.

93. *Actitis macularia* (Linnæus). Spotted Sandpiper.

COUES, 1878, p. 644; summers throughout the region, specimens taken at Pembina, June 4, and Mouse River, August 10, 1873. JUDD, 1917, p. 15; a rare bird on the prairies, more common near the Turtle Mountains, where it breeds.

A few were found at Lake Upsilon, Turtle Mountains, from July 30 to August 7, 1920. At Devils Lake, in 1921, the first were seen on May 13, and they were observed almost daily on Creel Bay, where they no doubt nested. They occurred at all other places worked about the state.

94. *Numenius americanus* Bechstein. Long-billed Curlew.

Allen, 1875, p. 67; a few pairs met with at quite distant intervals from the Missouri to Montana. Coues, 1878, p. 645; breeds in moderate numbers about Pembina, the only locality where it was observed during the first season. Coues, 1893, p. 276; April 17, 1805, Lewis and Clark report seeing a curlew, *Numenius longirostris*, below Williston. Coues, 1897, p. 176; Bell shot two curlews near Fort Union in August, 1843. Thwaites, 1905, p. 369; on June 22, 1833, Maximilian records seeing the great curlew near the mouth of the Little Missouri River, and October 11, flocks of curlew near Fort Union.

The long-billed curlew is apparently rare in the state. There is one in the Williams Collection taken at Mandan, June 14, 1903. There are mounted specimens in the Agricultural College Museum, taken at Williston, July 26, 1913, and at Mandan, June 14, 1903. The species is reported to breed across the Missouri River, about ten miles south of Williston. Mr. Henry Williams reports that they breed at Ardoch, twenty miles south of Grafton. Mr. J. D. Allen states that in 1881 curlews nested on the prairie north of Mandan, but a few years later they became scarce and he has not seen one for several years. Senator Crawford, of Sentinel Butte, writes that he saw but two pairs during the summer of 1921 and that the last of June they were nesting in the vicinity. No live birds were seen during the time in the field.

95. *Numenius borealis* (J. R. Forster). Eskimo Curlew.

Baird, 1858, p. 744; records two specimens taken in 1856 by Dr. Hayden. Hayden, 1863, p. 175; not uncommon, high up toward the sources of the Missouri. Specimens were taken near Fort Union.

96. *Squatarola squatarola* (Linnæus). Black-bellied Plover.

McChesney, 1878, p. 86; observed it in Dakota Territory only during the fall migration about October 25; quite common. Judd, 1917, p. 15; tolerably common migrant the last week in May, usually in very small flocks or singly, and sometimes seen with the golden plover.

A mounted specimen is in the Williams Collection at Grafton, taken September 21, 1906, and a mounted female at the Agricultural College from Upper des Lacs Lake, May 18, 1913, collected by H. E. Peck. The Museum of Zoology Collection contains a male taken September 11, 1913, at Grafton, and another collected November 6, 1921, near Grafton, by H. V. Williams.

This species was not noted in 1920, but in 1921 four were seen on Creel Bay, May 26, in company with Baird's and other sandpipers. They fed there until May 31, after which date none were seen.

97. *Charadrius dominicus dominicus* (Müller). Golden Plover.

Baird, 1858, p. 691; one taken at Fort Berthold, McLean County, September 16, 1856, by Dr. Hayden. Coues, 1878, p. 633; no golden plovers are seen in summer in any portion of the region explored. They pass through in large numbers in May

and return the latter part of September, being abundant at this time in the Mouse River region, where many specimens were shot September 27, 1873. JUDD, 1893, p. 382; they pass in small flocks, feeding on burned fields or prairies. JUDD, 1917, p. 15; common migrant, usually arrives second week in May. A number of flocks were seen moving south early in July, 1895. FREEMAN, 1919, p. 12; observed frequently in the fall, September 21.

A male and female of this species, taken at Stump Lake, August 21, 1891, are in the Museum of Zoology Collection, the gift of Alfred Eastgate. There are several in the Agricultural College Collection, two of them labelled Kenmare, Ward County, May 13, 1914, H. E. Peck. The Williams Collection contains one taken at Grafton, September 7, 1907.

The species is apparently becoming much less abundant than formerly. Only one small flock was seen, at Devils Lake, May 24, 1921. Mr. Alfred Eastgate saw a flock of about five hundred at Bottineau in May, 1920.

98. *Oxyechus vociferus* (Linnæus). Killdeer.

COUES, 1878, p. 634; abundant throughout the summer in all suitable places. Specimen taken June 11, 1873, at Pembina. HOFFMAN, 1882, p. 403; rather frequent on sand-bars above the village (Fort Berthold) and along the pools of water farther inland. JUDD, 1917, p. 15; common summer resident; first arrivals, March 30.

This species is quite common in all the parts of the state worked. In 1921 it was at Devils Lake, May 2, when we arrived, and a pair with downy young was seen there July 13, 1921.

99. *Ægialitis semipalmata* (Bonaparte). Semipalmated Plover.

JUDD, 1917, p. 15; rare, one seen by Dr. Bishop at Rock Lake, May, 1895. FREEMAN, 1921, p. 12; rare, May 17.

In 1920 a semipalmated plover was seen at Devils Lake on July 14 and several were noted in August at Lake Upsilon, Turtle Mountains. One was taken from a flock of least sandpipers on August 4. May 17, 1921, is the earliest record I have, when only two or three were seen. Others were noted on May 19 and 25 and June 1, and one was taken on July 19 at Devils Lake.

100. *Ægialitis meloda* (Ord). Piping Plover.

REED, 1904, p. 130; nest from Devils Lake, Benson County, May 26, 1901. JUDD, 1917, p. 15; Devils Lake near Graham's Island.

In 1920 adults with half-grown young were seen July 14; a juvenile bird was taken from a brood of four at East Bay, Devils Lake, July 25; several were seen on August 21. On July 24, 1921, several adults with broods of young, some of which were only a few days old, were noted on the Devils Lake beaches; July 19 a brood of nearly grown young were found at Minnewaukan Bay. The species is not rare as a summer resident in the Devils Lake region.

101. *Podasocys montanus* (J. K. Townsend). Mountain Plover.

ALLEN, 1875, p. 66; two or three small flocks were met with in September, but generally they were seen only in single pairs at intervals of several days.

102. *Arenaria interpres morinella* (Linnæus). Ruddy Turnstone.

Judd, 1917, p. 15; tolerably common around Rock Lake in 1895.

This species was not seen in July and August, 1920, but at Devils Lake in 1921 they were very common after May 23, when about fifty were seen, until June 11, when they left the lake. From May 25 to June 5 hundreds were seen each day feeding or resting along the rocky shores of Creel Bay and Fort Totten Bay. These were all in breeding plumage and quite tame.

103. *Bonasa umbellus umbelloides* (Douglas). Gray Ruffed Grouse.

Keeney, 1875, p. 220; found ruffed grouse along the Red River in scrub timber near Fargo, October, 1875. Judd, 1917, p. 15; common in the Turtle Mountains.

The species was found to be very common in the timber of the Turtle Mountains in July and August, 1920. There were twelve mounted specimens in the museum at the State Fish Hatchery at Lake Upsilon, which had been taken in the vicinity. Most of these birds were light gray with black ruffs and tail bands, but a few were a dark reddish chestnut with red ruffs and copper tail bands. Mr. Alfred Eastgate, who has collected many of these birds, says that both the red and gray forms occur in the same covey. My own experience agrees with this and suggests a dichromatic phase.

In the Museum of Zoology Collection are seventeen specimens from the Turtle Mountains, ten with gray-colored tails and seven with brown- or chestnut-colored tails; all but two have black ruffs and tail bands; the exceptions have chestnut-colored ruffs and copper-colored tail bands. This seems to be almost the extreme of the red phase, for I saw but one other in North Dakota that had more of the red color.

104. *Lagopus lagopus lagopus* (Linnæus). Willow Ptarmigan.

Mr. Russell Reid reports that a poorly mounted specimen taken October, 1909, in the Kildeer Mountains, Dunn County, was sent to J. D. Allen, at Mandan.

The species is a straggler or accidental winter visitant in the state. Senator Lewis F. Crawford, of Sentinel Butte, writes that he has seen one specimen, killed a few years ago in the western part of the state near Kildeer. This is probably the specimen referred to above.

105. *Tympanuchus americanus americanus* (Reichenbach). Prairie Chicken.

Thompson, 1890, pp. 514-515; in 1883 it began to be common at Pembina. Judd, 1917. p. 15; common summer resident.

The species seems to gradually follow the settlement of the country and to now have a quite general distribution over the state in the prairie regions. There were thirty or more, August 9, 1921, in one flock near Bottineau, fifteen miles south of the United States boundary. A few were seen near Grafton in the Red River Valley, about forty miles south of Pembina, where Dr. Coues did not find it in 1873. A few were found at Medora and at Williston residents said it was common.

106. *Pediocœtes phasianellus campestris* Ridgway. Prairie Sharp-tailed Grouse.

BAIRD, 1858, p. 627; one taken at Fort Union by Dr. Hayden; one taken at Fort Union, 1843, by J. J. Audubon. COUES, 1878, p. 630; common from Pembina to the Mouse River; secured a number of specimens from June 4 to August 24, 1873. HOFFMAN, 1882, p. 403; several specimens secured by the Indians in timber four miles west of the Agency at Fort Berthold. COUES, 1893, p. 274; April 15, 1805, on the high plains of McLean County, Lewis and Clark record many grouse which appear to be mating. COUES, 1897, p. 26; Audubon says on June 11 he saw a fine flock of sharp-tailed grouse near the mouth of the Knife River, Mercer County: p. 87; on July 13, 1843, Harris saw six sharp-tailed grouse near Fort Union, and on July 29 Harris and Bell shot an old and young of this species. THWAITES, 1906, p. 199; October 11 to 30, 1833, Maximilian records seeing flocks of prairie hens near Fort Union: p. 208; October 31, numerous flights of prairie hens were crossing the river in flocks of thirty or forty. FREEMAN, 1921, p. 12; winter visitant, uncommon.

There are three immature specimens in the Museum of Zoology Collection, taken in Ramsey County, August 2, 1900, by Charles L. Cass. The species is common in the Devils and Stump lakes region, especially on brushy areas near timber. It also occurs in summer on the open prairie, and is found throughout the state in suitable habitats. It was found to be very common in the Turtle Mountain region in the clearings and open fields.

In winter this species migrates southward and enters all the timber tracts in numbers. Mr. Williams, of Grafton, tells me that the Columbian sharp-tail is found in the northern parts of the state at that time.

107. *Centrocercus urophasianus* (Bonaparte). Sage Hen.

ALLEN, 1875, p. 65; none seen east of the Little Missouri. HOFFMAN, 1882, p. 403; not common at the village, Fort Berthold, McLean County, but reported more abundant further west. ROOSEVELT, 1885, p. 149; the sage grouse is preëminently a grouse of the plains and is never found near trees; he shot them on the high plains west of his ranch. BENDIRE, 1892, pp. 106-107; range of sage grouse in the state is western North Dakota.

The sage hen was not seen alive, but several people reported its occurrence. Carl Olsen told me that he had shot some in recent years about thirty miles southwest of Medora. Victor File, of Medora, said that in 1915 he found them common near Marmarth, Slope County, where he shot several. Hon. Lewis Crawford, of Sentinel Butte, Billings County, in a letter to the writer dated August 23, 1921, says the sage grouse is plentiful about thirty miles south of there. At one place on the Cannonball River he has seen thousands of cocks on an old prairie dog town, bulling. In the breeding season all the males come together for this show-off, and at this time are very gentle and can be approached up to within fifty feet. The females are on their nests at this time and very rarely seen at the gathering.

108. *Ectopistes migratorius* (Linnæus). Passenger Pigeon. Extinct.

COUES, 1874, p. 388; along the Missouri often saw small flocks and noticed quite a number of nests in small trees between Fort Pierre and Fort Berthold. COUES, 1878, p. 628; countless flocks seen during the voyage down the Red River and at Pembina, where specimens were collected from June 4 to 14, 1873. Took one nest containing a single egg, June 13, and one bird in the Turtle Mountains in July. ABBOTT, 1880,

p. 985; one small flock met with in July, 1879, near Pembina. COUES, 1897, p. 156; August 23, 1843; Audubon says near mouth of Little Missouri they were passed by passenger pigeons. THWAITES, 1906, p. 32; on July 10, 1833, Maximilian records seeing many wild pigeons near Fort Union. JUDD, 1917, p. 29; J. F. Rickbell, of Cavalier, Pembina County, saw a number of flocks of fifty to a hundred in 1880 and 1881, and shot several.

109. *Zenaidura macroura carolinensis* (Linnæus). Mourning Dove.

COUES, 1878, p. 628; common at Pembina in June, 1873. HOFFMAN, 1882, pp. 402-403; several specimens observed only during the first half of September. THWAITES, 1905, p. 385; at Fort Union, Maximilian records seeing Caroline doves in July. JUDD, 1917, p. 15; tolerably common summer resident; nests on the prairies and in the Turtle Mountains.

This was found to be a very common species throughout the state. It is one of the most beneficial birds, for it feeds largely on seeds of injurious weeds.

110. *Cathartes aura septentrionalis* Wied.. Turkey Vulture.

COUES, 1878, p. 627; frequently seen in the Red River region. HOFFMAN, 1882, p. 402; apparently not rare at Fort Berthold, McLean County. S. C. C., 1887, p. 414; seen occasionally near Bismarck. THWAITES, 1905, p. 337; on June 13, 1833, Maximilian saw a high tree entirely covered with turkey buzzards, in Emmons County along the Missouri River. JUDD, 1917, p. 17; straggler in prairie region, tolerably common around Devils Lake. BAILEY, 1920, p. 69; three turkey vultures seen at Sweetwater Lake.

The Williams Collection contains a specimen taken at Ardoch, Walsh County, October 4, 1914, by Mr. Williams. He has other records for Grafton of April 20, 1902, and May 22, 1921. Mr. Russell Reid informs me that it is not common at Bismarck; a specimen was taken there July 19, 1921.

A specimen was seen near Devils Lake on May 9, 1921, and another on May 18.

111. *Catharista urubu* (Vieillot). Black Vulture.

BOARDMAN, 1880, p. 106; saw a flock of black vultures a few miles north of Sanborn, Barnes County, and shot one to make sure of the identity.

This is the only Dakota record known to the writer.

112. *Elanoides forficatus* (Linnæus). Swallow-tailed Kite.

COUES, 1878, p. 147; "I am informed by my valued correspondent, Dr. C. E. McChesney, U. S. A., of the occurrence of *Elanoides forficatus* at Fort Sisseton, Dakota, during nearly the whole of last winter. [This fort was in Roberts County, not far from the North Dakota line.] This account tallies with Trippe's Minnesota record, north of Mille Lac, lat. 47°, while at Pembina, Dakota, lat. 49°, I was assured by an officer of the occasional appearance of the bird there."

113. *Circus hudsonius* (Linnæus). Marsh Hawk.

ALLEN, 1875, p. 64; rare in the breeding season, more common in August and September. COUES, 1878, p. 619; common throughout the region. Specimens were taken at Pembina, June 3 and 11, 1873; at Turtle Mountains, July 28, and Mouse River, August 10-19. HOFFMAN, 1882, p. 402; not common at Fort Berthold. JUDD, 1917, p. 15; very common summer resident.

This is a common species in all parts of the state. On June 29 a nest containing five small young was found in a dry marsh in tall, coarse grass. This is one of the most beneficial hawks, as it feeds principally on injurious mammals, all kinds of mice and ground squirrels.

114. *Accipiter velox* (Wilson). Sharp-shinned Hawk.

COUES, 1878, p. 620; recognized on one occasion when a female was taken at Mouse River, September 3, 1873. WARREN, 1890, p. 348; a specimen from Fort Buford, Williams County, taken September, 1887. JUDD, 1917, p. 17; rare, two specimens secured in 1895.

No live birds were seen, but there is one from the Turtle Mountains mounted in the Biological Station Museum at Devils Lake. The Williams Collection contains one taken at Grafton, September 8, 1912, by Mr. Williams.

115. *Accipiter cooperi* (Bonaparte). Cooper's Hawk.

BENDIRE, 1892, p. 193; Cooper's hawk in the vicinity of Grand Forks, North Dakota, occasionally nests on the ground according to George G. Cantwell.

The Williams Collection contains a female Cooper's hawk taken at Grafton, May 24, 1914, by Henry Williams.

The species was not fully identified in the field, although a hawk seen at a distance was recorded as Cooper's.

116. *Astur atricapillus atricapillus* (Wilson). Goshawk.

JUDD, 1917, p. 17; have seen head and feathers of two shot in north end of Towner County.

A male in the Museum of Zoology Collection was taken January 21, 1917, at Grafton, by H. V. Williams; the Williams Collection has one taken at Grafton, April 9, 1907; and there is a mounted bird without data in the State Biological Station Museum.

The species enters North Dakota in the fall, and some winter there, according to Mr. Williams. It is one of the most injurious of all the hawks, as it lives principally on game birds and mammals.

117. *Buteo borealis krideri* Hoopes. Krider's Hawk.

JUDD, 1917, p. 17; common migrant and also breeds in the same region as the red-tail, and probably types of both will be found intermingling and breeding.

The Williams Collection contains a fine specimen taken at Grafton, September 6, 1909, by Mr. Williams.

On August 23, 1920, I saw at short range a hawk which I was able to identify as Krider's. This, like the red-tail, is mostly beneficial in its food habits, feeding largely on injurious mammals.

118. *Buteo borealis calurus* Cassin. Western Red-tail.

COUES, 1878, p. 624; frequently observed in the west, but the only individual taken was at Mouse River, September 14, 1873. JUDD, 1917, p. 17; common migrant, breeds in Turtle Mountains and in timber around Devils and Sweetwater lakes.

The above note is given for the eastern form, and both that and the western doubtless occur in the state. Several were shot in August, 1920,

and a number of others seen which were hard to identify as either species. There are a number of mounted birds of both species in the Williams Collection. A fine specimen was also seen there, a partly albino male.

119. *Buteo borealis harlani* (Audubon). Harlan's Hawk.

Schmidt, 1904; central section as a migrant. Cameron, 1907, p. 262; one from North Dakota, spring of 1890, now in British Museum. Saunders, 1921, p. 173; this subspecies has been taken in North Dakota.

Mr. Alfred Eastgate is responsible for two records for this hawk; one taken at Stump Lake, October 2, 1902, and another at Dry Lake, October 14, 1912. The only specimen seen was in the Williams Collection, a large female collected at Grafton, May 1, 1916, by Henry Williams. It is now in the Museum of Zoology Collection.

120. *Buteo lineatus lineatus* (Gmelin). Red-shouldered Hawk.

Schmidt, 1920, p. 298; summer resident. Bendire, 1892, p. 219; probably occurs in small numbers in the more heavily timbered parts of North Dakota. The species was not seen in the field.

121. *Buteo swainsoni* Bonaparte. Swainson's Hawk.

Baird, 1858, pp. 21, 22; female taken at Heart River, North Dakota, September 21, 1856, and two females from the Little Missouri River, taken September 12, 1856, by Dr. Hayden. These were published as *Buteo bairdii* Hay, which name was later reduced to the synonymy of the present species. Allen, 1875, p. 64; more or less common; obtained an adult male on Heart River, June 25, 1873. Coues, 1878, p. 624; very abundant in North Dakota, where many specimens were taken from July 15 to September 9, 1873. Bendire, 1892, p. 239; Capt. B. F. Goss says he found this speceis breeding in North Dakota in the high timber along the streams from forty to fifty feet up and in low brush patches on the prairie in the lake region, where its nests were but two to four feet from the ground. Reed, 1904, p. 162; set of eggs collected May 21, 1897, in Stark County, by Roy Dodd. Judd, 1917, p. 17; an abundant summer resident, nesting in small bushes and also in tall trees. In July they appear in large numbers to feed on grasshoppers, gophers, mice, toads, etc. Writing in 1910, one would say they were rare birds and not found nesting at all, nor is there a summer flight of this species.

A male in the Museum of Zoology Collection was taken at Stump Lake, May, 1897, by Alfred Eastgate. In the collection of Mr. Williams at Grafton are a number of mounted birds, all in different plumages, some very dark and others quite light. This species must have greatly decreased in numbers or has changed its habits. At present it is rarely found nesting and is not seen in many localities where it was formerly abundant. It was first seen at Cando, June 3, 1921, when I secured one. In July and August I saw a few others in the prairie regions, but they seemed no more common than the red-tails. This is doubtless the most beneficial of the hawks in its food habits and should not be destroyed.

122. *Buteo platypterus* (Vieillot). Broad-winged Hawk.

Judd, 1917, p. 17; fairly common straggler, no evidence of its breeding here has been noticed.

An adult female was taken August 23, 1900, at Devils Lake by Alfred Eastgate, and is now in the Biological Station Museum. One was seen and

taken at Cando, in a small grove of trees at the edge of town, on June 7. I saw one in 1920 at Lake Upsilon, Turtle Mountains, on August 2, and took one at Devils Lake, August 23. Another was seen there August 24, 1920.

123. *Archibuteo lagopus sancti-johannis* (Gmelin). Rough-legged Hawk.

JUDD, 1917, p. 17; very early spring and late fall migrant, first seen the last of March, tolerably common.

Mr. Reid reports that it is sometimes seen during migration and that a pair wintered in a small coulee north of Bismarck during 1920-21.

This bird was not seen in life, but there is a mounted specimen in the Williams Collection, taken November 1, 1908, at Grafton, where the species is a winter visitor.

124. *Archibuteo ferrugineus* (Lichtenstein). Ferruginous Rough-leg.

BAIRD, 1858, p. 35; a female taken October 12, 1855, on the Little Missouri River by Lieut. E. H. Warren. ALLEN, 1875, p. 65; one of the most common species, several nests found containing young. The nest is often a large, bulky structure, three or four feet in diameter, built of large sticks, mixed with the ribs of antelope and bison, and is placed on the ground or rocks usually near the summit of buttes. COUES, 1878, p. 626; found breeding in the Pembina Mountains by Lieut. F. V. Greene's party. HOFFMAN, 1882, p. 402; found in the timber of the river bottoms, though not very common. BENDIRE, 1892, p. 260; Capt. Goss wrote that the ferrugineus rough-leg was not uncommon in the high, broken prairie and lake regions of northwest North Dakota. In May, 1880, he took four sets, the nests all on the ground on rocky hillsides and generally near large boulders. REED, 1904, p. 165; a set taken April 29, 1900, in Stark County, by Roy Dodd. BENT, 1907, pp. 213-214; corrects the name of a rough-legged hawk, supposed to have been the American, found breeding in Nelson County, June 4, 1901, and published in *Auk*, Vol. XVIII, p. 393, and says: "This nest, I am satisfied, belonged to a pair of ferrugineous rough-legs." On June 17, 1902, Dr. L. B. Bishop found a nest near Lake Washington, North Dakota. All these developed the melanistic plumage. JUDD, 1917, p. 17; very common summer resident, breeding in considerable numbers in the hills in the northern part of Towner County. First seen early in April.

In the collection of the Museum of Zoology is a male in melanistic plumage, collected October 3, 1920, at Grafton, Walsh County, by H. V. Williams. The museum at the Biological Station, Devils Lake, contains a mounted bird, and there is another in the Williams Collection, taken at Grafton, October 1, 1920, by Henry Williams. The only nest known to the writer was found at Stump Lake, July 24, 1920. A pair had nested for years in a thick ash forest at the Wishart Ranch named "Hawks' Rest" by Mrs. F. M. Bailey, who made this place her headquarters while studying the birds of the Stump Lake Region and who wrote of this particular nest (Condor, 1918, Vol. XX, No. 4, p. 136). This species must be greatly reduced from its former numbers, as but two live birds were seen, one August 9, 1920, and another July 11, 1921, both near Bottineau. It is almost wholly beneficial, living on mice, ground squirrels and gophers.

125. *Aquila chrysaetos* (Linnæus). Golden Eagle.

ALLEN, 1875, p. 65; occasional: young one captured on Heart River. COUES, 1897, p. 107; Audubon says on July 21, 1843, near Fort Union, he saw young golden eagles.

This is a rare visitant or straggler in North Dakota. Only three are in

the state collections. One in the Agricultural College Collection is from Bismarck; there is a mounted one in the Rough Riders' Hotel at Medora, taken near there, and there is an immature bird in the Williams Collection, taken April 5, 1921, at Olga, Cavalier County. We were told by Mr. Halliday, a federal trapper, of a nest on an isolated butte near Medora. This species is considered quite destructive to game birds, and also kills hares, rabbits, and even young lambs, pigs and poultry.

126. *Haliæetus leucocephalus leucocephalus* (Linnæus). Bald Eagle.

COUES, 1878, p. 627; frequent last week in May, 1873, along the Red River from Moorehead to Pembina. Several nests were noticed upon the tops of tall, isolated trees; upon one of the nests the parent was observed sitting. HOFFMAN, 1882, p. 402; occasional visitor in the vicinity of Fort Berthold. COUES, 1893, p. 265; April 10, 1805, Lewis and Clark shot bald eagles and saw many nests in tall cottonwoods near Fort Berthold, and on April 12 shot one near the mouth of the Little Missouri. COUES, 1897, p. 176; August 2, Owen climbed a tree to a white-headed eagle's nest and drove a young one out, which was brought to Fort Union alive. It is remarkable that the young should be in the nest at this late season. JUDD, 1917, p. 18; not common, breeds; a young bird was taken from the nest in the Turtle Mountains in 1890; two were seen in 1895, one of which was taken near Rock Lake.

No live birds were seen, but I have examined a mounted bird, taken at Medora, November, 1920. Captain Thomas Lonnevik took an immature male, October 15, 1921, at Devils Lake. This is in the Biological Station Museum. There is an immature male in the collection of the Museum of Zoology, taken by Henry Williams at Northwood, Nov. 25, 1913.

The bald eagle lives principally on fish, either dead ones cast on shore or upon those captured by other fish-eating birds. It is reported to feed upon water fowl also.

127. *Falco rusticolus rusticolus* Linnæus. Gray Gyrfalcon.

Mr. Reid reports two specimens at Mandan, taken at Hazen, Mercer County, March, 1919.

There is one adult in the Williams Collection taken at Grafton, October 7, 1908. This species must be considered as an accidental visitant or straggler in North Dakota.

128. *Falco mexicanus* Schlegel. Prairie Falcon.

HAYDEN, 1863, p. 152; along the Missouri, though not abundant. JUDD, 1917, p. 18; common, especially during August and September. The only species of hawk seen taking poultry. Have seen them swoop down in the main street of the town after their prey.

The species may have been common some years ago, but I failed to find it so during my work in the state. Mr. Alfred Eastgate tells me that it is a common migrant and breeds along the Mauvaise Coulee in Towner County. On August 9, 1920, I noted a fine bird, the only one seen, on a fence post near a small alkali lake, about five miles southwest of Bottineau.

129. *Falco peregrinus anatum* Bonaparte. Duck Hawk.

COUES, 1897, p. 156; Audubon says he saw many peregrine falcons near Fort Clark, Oliver County: p. 176; on August 2, Bell and Owen saw a peregrine falcon feeding

its young near Fort Union. REED, 1904, p. 169; a set of eggs from Stark County, taken May 4, 1901, by Edw. Dodd. JUDD, 1917, p. 18; not common, several seen during the season. One female taken in June, 1895, by Dr. Louis Bishop. BAILEY, 1920, p. 69; a duck hawk flew swiftly in, darted down and seized a coot at Island Lake, Ramsey County.

Mr. Alfred Eastgate, who lived for several years (1894-1915) on the shore of Stump Lake, Nelson County, told the writer that duck hawks were common there from October 10 to November 10 each year. Mr. Williams mounted one taken in October, 1904, at Glasston, by C. Storey. On May 19, 1921, I saw a bird perched on a stone duck blind on the point west of Creel Bay, Devils Lake. This was the only specimen seen alive, but Mr. D. R. Ducke, of the State Fish and Game Commission, gave me a skin of an immature bird taken by him in Eddy County, April 10, 1910.

130. *Falco columbarius columbarius* Linnæus. Pigeon Hawk.

ALLEN, 1875, p. 64; seen at distant intervals on the Heart River in September. COUES, 1897, p. 162; on September 5, on the upper Missouri, Audubon saw a pigeon hawk chase a spotted sandpiper, which dove under the water and escaped. JUDD, 1917, p. 18; hawks seen flying at a distance were assigned to this species. Rare, if it occurs at all.

Mr. Alfred Eastgate says it is a common migrant. The skin of a male taken September 16, 1914, at Grafton, Walsh County, by H. V. Williams, is in the Museum of Zoology Collection. No living birds were seen, but there is a mounted one without data in the Biological Station Museum at Devils Lake, and another in the Williams Collection, taken at Grafton, June 18, 1912, by Mr. Williams, who says it nests there rarely. There is also a mounted male in the Agricultural College Museum from Kenmare, Ward County, taken May 2, 1913, by H. E. Peck.

131. *Falco columbarius richardsoni* Ridgway. Richardson's Pigeon Hawk.

COUES, 1874, p. 349; young male taken at Fort Rice by General Alfred Sully. COUES, 1878, p. 623; one specimen, the only individual of this species observed, was taken on the headwaters of the Mouse River, September 8, 1873. BENDIRE, 1892, p. 304; U. S. National Museum contains some from North Dakota.

The species was not seen in the field, and so far as known there are no specimens in the state collections.

132. *Falco sparverius sparverius* Linnæus. Sparrow Hawk.

COUES, 1878, p. 623; very abundant throughout the region surveyed. Many specimens were taken from Pembina to Mouse River, June 19 to August 30, 1873. HOFFMAN, 1882, p. 402; frequently seen in pursuit of small birds near the village. COUES, 1897, p. 24; on June 10 a sparrow hawk was killed above the Little Missouri River.

This is a common summer resident of all the wooded areas; it was present on my arrival at Devils Lake, May 3, 1921, and one was found nesting the last of that month in an oak tree at the side of the road on the Rock Island Military Reservation. Of four specimens taken, three are, no doubt, of this eastern species, while one is referred to the western or desert form.

The sparrow hawk is a very beneficial species, living princpally upon insects and injurious mammals.

133. *Falco sparverius phalaena* (Lesson). Desert Sparrow Hawk.

There is a specimen in the Williams Collection, taken at Grafton, May 12, 1907. One of my specimens, an adult female taken at Devils Lake, May 10, 1921, is referred to this form.

134. *Pandion haliaëtus carolinensis* (Gmelin). Osprey.

JUDD, 1917, p. 18; rare, one seen at Snyder Lake, Towner County, April 24, and again on May 28, 1895.

This species was not seen in the field, but Mr. Williams told me that he saw one which was shot at Niagara, Grand Forks County, on September 25, 1920, and another at Grafton, April, 1921.

135. *Aluco pratincola* (Bonaparte). Barn Owl.

This seems to be a very rare species in North Dakota. It was not observed in the field. Mr. Alfred Eastgate has a record for Grand Forks, November, 1891. There is a mounted specimen in the Williams Collection taken at Oakes, Dickey County, September 1, 1912. Mr. J. D. Allen, of Mandan, has mounted a bird collected in Stutsman County, September 7, 1921, by Eddie Schutt, and two from Hebron, Morton County, taken September 6, 1921, by Joe Wagenhopper.

136. *Asio wilsonianus* (Lesson). Long-eared Owl.

ALLEN, 1875, p. 64; occasional, two specimens obtained. JUDD, 1917, p. 18; not common; one nest found May 25, 1895, in bushes along Big Coulee in the northern part of the county. BAILEY, 1919, p. 227; family of three-quarter grown specimens on Sweetwater Lake on August 17, 1917.

A nest of this species was found at Hay Creek, near Bismarck, on May 22, 1921, by Russell Reid (see photograph).

A mounted specimen without data is in the Biological Station Museum. It was probably taken near Devils Lake. I saw, in a deep draw near Medora, a female with three young and an unhatched egg in an old magpie's nest built in a thicket of trees. On June 19 the oldest of these young was one-half grown, the next was much smaller, while the youngest was only about half as large as the oldest. This is a very beneficial species, feeding almost entirely on mice and small mammals injurious to the farm crops.

137. *Asio flammeus* (Pontoppidan). Short-eared Owl.

ALLEN, 1875, p. 64; apparently the most common of the owls. LARSON, 1913, p. 94; occasionally seen; could be found almost anywhere in McKenzie County in the winter of 1912-13. BAILEY, 1915, p. 174; saw a number flying about in the daytime, July 8 and 9, 1912, between Stump and Devils lakes. JUDD, 1917, p. 18; common summer resident, usually arrives third week in April; full set of eggs was found May 18.

This owl is, no doubt, the most common one in North Dakota. Mounted specimens are in all the state collections. I found one, May 26, 1921, in a marsh at the north end of Creel Bay, and at Bottineau, July 11, saw a number in the road after dark. This species destroys immense numbers of small mammals injurious to the farm crops and, like the two preceding species, should always be protected.

138. *Strix varia varia* Barton. Barred Owl.

COUES, 1874, p. 309; Dr. Hayden's Missouri River specimen remains the westernmost on record for the species. ALLEN, 1875, p. 64; met with on the Missouri at Fort Rice, 1873. HOFFMAN, 1882, p. 401; said to be of frequent occurrence, though only a single specimen was found at Fort Berthold.

My only record is of a mounted specimen in the Williams Collection, taken at Grafton, October 3, 1904. This species is also a beneficial one, but as it is rare in North Dakota is not of much economic importance.

139. *Scotiaptex nebulosa nebulosa* (J. R. Forster). Great Gray Owl.

RIDGWAY, 1914, p. 637; one from Mandan, North Dakota.

Mr. Alfred Eastgate writes me that he has a specimen taken at Grand Forks in January, 1892.

This species, like the last, was not noted by Coues or Judd, nor did I see any in life. A mounted specimen in the Williams Collection was taken near Pembina, February 3, 1900. It only occurs as a rare winter visitor. It is not beneficial, since it feeds mostly upon game birds and mammals.

140. *Cryptoglaux funera richardsoni* (Bonaparte). Richardson's Owl.

JUDD, 1917, p. 18; rare winter resident and migrant.

The Williams Collection has a specimen taken at Grafton, April 8, 1904. The Agricultural College Museum contains a male taken at Grafton, December 16, 1910, by Mr. Williams, who reports it as common only during the winter months. Mr. Alfred Eastgate records one from Stump Lake, March 27, 1904. This, like the great gray owl, is only a rare winter straggler in North Dakota.

141. *Cryptoglaux acadica acadica* (Gmelin). Saw-whet Owl.

JUDD, 1917; rare, taken in winter only.

The Agricultural College Museum contains a mounted bird taken on the College Campus, October 10, 1920. I saw specimens in the Williams Collection, taken November 10, 1909. Mr. Williams told me it nested at Grafton. This and the preceding species are of little economic importance, as they occur but rarely. In general, they are beneficial, feeding mostly upon mice.

142. *Otus asio asio* (Linnæus). Screech Owl.

FREEMAN, 1921, p. 12; fairly common, both the fuscous and gray phases found. A pair have been observed for several years in Island Park.

Mr. Reid records one in the red phase found west of Mandan, November 13, 1921.

I saw a mounted specimen in the collection of William Shunk, of Anselm, that had been taken there recently. One in the Williams Collection was taken January 9, 1908. One was killed at Stump Lake, 1906, and mounted by Alfred Eastgate.

143. *Bubo virginianus virginianus* (Gmelin). Great Horned Owl.

BAIRD, 1858, p. 51; female taken at Fort Union. COUES, 1878, p. 618; a pair with two young observed at Pembina early in June, 1873. HOFFMAN, 1882, p. 401; was

informed that the species is not rare. A wing was found in possession of an Indian who used it as a fan. Coues, 1893, p. 272; April 14, Lewis and Clark record the killing of a large hooting owl. Coues, 1897, p. 97; Audubon says he shot a great horned owl near Fort Union.

The Williams Collection contains three forms of horned owls; one of these, which I have referred to this species, was dark, marked with yellow and rufous, like our Michigan birds. It was taken at Grafton, November 10, 1903. Another typical specimen was also collected at Grafton, November 1, 1903. Mr. Eastgate records one from Larimore, January, 1906.

144. *Bubo virginianus pallescens* Stone. Western Horned Owl.

Judd, 1917, p. 19; common resident of Turtle Mountains, where it breeds. Nests were found with eggs in February and March.

This is the most common form found in North Dakota. I saw several mounted specimens in the state collections. On May 28, 1921, I found a nest in a big willow tree at the edge of Fort Totten Lake in Sully Hill National Park near Fort Totten. It contained three downy young nearly half grown. These were brought to me at the Biological Station on June 11 by the keeper of the park, Mr. Triska, who told me that the parents were catching the tame ducks in the park pond, so he shot the female, but it escaped. The largest one of the young is in the North Dakota Biological Station Museum. It was well grown, with tail and wing feathers about half length. The two smaller ones are in the Museum of Zoology Collection. The species probably destroys not only a considerable amount of poultry and game birds but also numbers of small mammals.

145. *Bubo virginianus subarcticus* Hoy. Arctic Horned Owl.

Ridgway, 1914, p. 751; one from Devils Lake, North Dakota.

This form is supposed to be only a winter visitant in North Dakota, but Mr. Williams, in whose collection are some fine specimens, says that it breeds at Grafton. A fall record was December 3, 1903.

146. *Nyctea nyctea* (Linnæus). Snowy Owl.

Deane, 1907, pp. 218-219; Mr. J. D. Allen, of Mandan, writes on March 11, 1907: "The snowy owls have not been as abundant this winter as last, when I had thirty sent to me. Some years ago I secured over 500 specimens and the following year over 350." Larson, 1913, p. 94; only one seen in McKenzie County in winter of 1912-1913. Judd, 1917, p. 19; common winter resident and migrant. Seen here from October to May. One seen at Rock Lake, July, 1910.

This species seems to be common in collections. Mr. Williams had a dozen or more, two of which were practically pure white. At the Williams shop seventy-five of these birds were mounted in one winter. A pair in the flesh was received at the Museum of Zoology, December 24, 1921, sent from Grafton by H. V. Williams. On account of their great numbers and destructive food habits they are, with the horned owl, a great menace to the game birds and mammals of the state. However, at some seasons of the year they destroy mice, gophers and other injurious mammals.

147. *Surnia ulula caparoch* (Müller). Hawk Owl.

JUDD, 1917, p. 19; rare, one specimen taken in the fall of 1902.

This species was seen only in collections. The Agricultural College Museum has a mounted male taken at Joliette, Pembina County, October 24, 1912, by Mr. Williams. At Grafton, I saw one taken there December 10, 1908. Mr. Williams reports that he had seen them only during that winter, when they were quite common.

148. *Speotyto cunicularia hypogaea* (Bonaparte). Burrowing Owl.

ALLEN, 1875, p. 64; not numerous, met with at intervals in the prairie dog towns from the Little Missouri westward. HOFFMAN, 1882, p. 402; rather common ten miles east of the village in the prairie dog town. WARREN, 1890, p. 365; a specimen from Fort Buford, taken September 29, 1887. BAILEY, 1918, p. 176; was told that a burrowing owl, here at the extreme eastern limit of its range, had nested in an old badger hole at Sweetwater Lake, Ramsey County.

The species ranges farther east than Bailey records. On July 24, 1921, I saw two families of five and six young each in an old pasture north of Grafton, Walsh County. They were living in old badger or ground squirrel burrows. At that time they were able to fly well. On July 11, 1921, two families with five and six young each, also able to fly, were observed about fourteen miles west of Bottineau. None were noted near Medora, though the habitat seemed very favorable for them. This owl is beneficial in habits and should be protected.

149. *Conuropsis carolinensis* (Linnæus). Carolina Paroquet.

THWAITES, 1906, p. 250; Maximilian mentions this species in a list of birds at Fort Clark, 1833. In 1843 Audubon saw them in South Dakota near Fort Pierre.

150. *Coccyzus americanus americanus* (Linnæus). Yellow-billed Cuckoo.

ALLEN, 1874, p. 63; several times observed along the Heart River. JUDD, 1917, p. 19; E. S. Bryant claims to have taken this species at Freshwater Lake. FREEMAN, 1919, p. 13; rare, occurs the latter part of May or early June.

This species was not seen, but it no doubt occurs rarely in the south and eastern parts of the state, as it is noted as a common breeder in South Dakota by Visher.[5]

On October 10, 1921, Henry Williams, of Grafton, received a bird in the flesh from Professor Miller, of Fargo.

151. *Coccyzus erythrophthalmus* (Wilson). Black-billed Cuckoo.

COUES, 1878, p. 615; a nest in Pembina Mountains was found July 12, 1873, which contained a single young bird. JUDD, 1917, p. 19; tolerably common summer resident in Turtle Mountains.

A common summer resident about Devils Lake in 1920 and 1921, and observed in the Turtle Mountains on August 7, 1900, and on June 4, 1921. It is a very beneficial bird, eating worms, caterpillars and other injurious forms of insect life.

[5] An Annotated List of the Birds of Sanborn County, South Dakota. *Auk*, Vol. XXX, No. 4, October, 1913.

152. *Ceryle alcyon* (Linnæus). Belted Kingfisher.

COUES, 1878, p. 615; general distribution along the Red and Mouse rivers. One was taken at Pembina, June 9, 1873. HOFFMAN, 1882, p. 401; not common at the settlement, but seen above and below it. THWAITES, 1906, p. 186; near Fort Union, September 28, 1833, Maximilian saw many kingfishers. JUDD, 1917, p. 19; tolerably common migrant. Rarely found nesting. FREEMAN, 1921, p. 13; a few nest here, April 2.

This species was not observed at Devils Lake, but two were seen at Lake Upsilon, Turtle Mountains, August 5, 1920, and at Lake Winnebegosis in the western end of the mountains on July 11, 1921. It was also seen at Cando, June 10, 1921, by Elmer T. Judd, and I found it at Fargo, July 27, 1921, along the Red River.

153. *Dryobates villosus villosus* (Linnæus). Hairy Woodpecker.

HOFFMAN, 1882, p. 401; observed among the groves near the bad lands east of the village. RIDGEWAY, 1914, p. 202; two adult males from North Dakota. SCHMIDT, 1904; lists this species from North Dakota. SCHMIDT, 1920, p. 302; lists this species as a common summer resident. FREEMAN, 1921, p. 13; permanent resident, seen every month in the year.

I did not see this species, but it no doubt occurs in the Red River region.

154. *Dryobates villosus leucomelas* (Boddaert). Northern Hairy Woodpecker.

COUES, 1878, p. 615; observed in heavy timber in the Turtle Mountains. One specimen taken there, July 20, 1873. (The above was given under the previous species name, *villosus*, but the bird was doubtless this form.) SCHMIDT, 1904; nests. JUDD, 1917, p. 19; tolerably common resident in the Turtle Mountains; breeds.

On July 20, 1920, a typical adult female was taken at Devils Lake. I did not see it during my stay in the Turtle Mountains.

Two specimens are in the Museum of Zoology, a male and female, taken at Grafton, February 28, 1922, by H. V. Williams.

The species feeds upon wood-borers and injurious insects.

155. *Dryobates pubescens medianus* (Swainson). Downy Woodpecker.

JUDD, 1917, p. 19; common summer resident in the Turtle Mountains; first seen in the middle of May.

A common resident of all the wooded areas worked. It was seen in the Turtle Mountains, August 1 to 7, 1920, and at Devils Lake, May 4, 1921. This, as well as the hairy woodpecker, is very beneficial in food habits, ridding the trees of wood-borers and other injurious insects.

156. *Picoides arcticus* (Swainson). Arctic Three-toed Woodpecker.

JUDD, 1917, p. 19; rare, Bryant collected one in the spring of 1894.

A mounted specimen is in the Williams Collection at Grafton, taken there January 23, 1912, by Mr. Williams. This was the only one seen. It occurs only rarely.

157. *Sphyrapicus varius varius* (Linnæus). Yellow-bellied Sapsucker.

COUES, 1878, p. 616; plentiful at Pembina, where it was breeding in June, 1873.

Specimens were taken June 5 to July 8 at Pembina, and September 16 at Mouse River. JUDD, 1917, p. 19; summer resident of Turtle Mountains. FREEMAN, 1919, p. 13; common summer resident, April 4.

Mr. Russell Reid reports that the species is sometimes seen during migration. Specimens were taken on April 24 and May 5, 1920, near Bismarck.

Many adults and young were observed in the Turtle Mountains from July 30 to August 7, 1920, and on June 5, 1921. I saw a nest in a big cottonwood tree on the Fargo College Campus in July, 1921. This species is considered injurious to trees, especially fruit trees, which it often girdles with its punctures.

158. *Phlœotomus pileatus abieticola* (Bangs). Northern Pileated Woodpecker.

The only specimens from North Dakota known to me are one in the Williams Collection taken at Grafton, May 30, 1905, and another in the Fargo College Museum, labelled Red River, October 16, 1915, Henry Williams. This is a beneficial species, eating ants and all kinds of wood-boring beetles and larvae.

159. *Melanerpes erythrocephalus* (Linnæus). Red-headed Woodpecker.

COUES, 1878, p. 617; common along the Red and Upper Missouri rivers. A specimen was taken at Pembina, June 9, 1873. JUDD, 1917, p. 19; rare; a straggler from the Red River flight.

This species was not seen at Devils Lake, but it was common at Medora in June, 1921, and was noted at Fargo, June 13, and at Grand Forks, July 21, 1921.

160. *Asyndesmus lewisi* Riley. Lewis's Woodpecker.

SCHMIDT, 1904; western and central North Dakota, rare.

A mounted specimen is in the Williams Collection, taken at Neche, Pembina County, October 13, 1916, by Peter D. Heilly.

161. *Centurus carolinus* (Linnæus). Red-bellied Woodpecker.

I am unable to find a published record from North Dakota. A skin of a male taken in September, 1897, at Stump Lake, Nelson County, by Alfred Eastgate, is in the Museum of Zoology Collection. It must be recorded as a rare straggler in the state.

162. *Colaptes auratus luteus* Bangs. Northern Flicker.

COUES, 1878, p. 617; common along the Red and Mouse rivers and seen at Pembina and Turtle Mountains. Specimens were taken from June 6 to September 3, 1873. HOFFMAN, 1882, p. 401; saw no living or fresh specimen, but in the Great Lodge of the Arickaras was a true *auratus* poorly mounted. RIDGWAY, 1914, p. 18; east of Rocky Mountains except North Dakota and Minnesota. On page 20 he refers the North Dakota form to *C. a. borealis*. JUDD, 1917, p. 19; common summer resident, Turtle Mountains.

This was found to be a very common species at Devils Lake from May 3, 1921, nesting in the ash forest and feeding on ants along the beaches of

the lake. It was also seen at all of the localities worked. This is a very beneficial species, eating many injurious insects, seeds and wild fruits.

163. *Colaptes cafer collaris* Vigors. Red-shafted Flicker.

HOFFMAN, 1882, p. 401; during the whole month of September at Fort Berthold, McLean County. BENDIRE, 1895, p. 134; ranges east to North Dakota. COUES, 1897, p. 24; June 12, Harris saw several red-shafted woodpeckers near Fort Union: p. 41; June 19, Harris and Bell brought a new bird like our common golden-winged woodpecker, but with a red mark instead of a black one along the lower mandible. In a foot-note Dr. Coues says, here is the original nidification of the curious flicker of the Upper Missouri region, which Audubon named *Picus ayresii*. It is the *Colaptes hybridus* of Baird, in which the specific characters of the golden-winged and red-shafted flickers are mixed in every conceivable degree and which later puzzled Audubon; p. 71; Audubon says: "On July 1, Harris and Sprague brought in the most curious set of five birds that I ever saw and which I think will puzzle all the naturalists in the world. These all belonged to one nest and were all differently marked."

Mr. Russell Reid reports that the species is frequent about Bismarck and that a pair nested on the High School grounds at Bismarck last May. He had seen hybrids of this and *luteus*.

But one specimen was seen in life, at Williston, near the Missouri River, June 7, 1921. At Grafton I saw a mounted specimen in the Williams Collection taken by Henry Williams on December 3, 1919. It was seen in the locality some time before it was taken. The form is no doubt very rare in that part of the state.

164. *Antrostomus vociferus vociferus* (Wilson). Whip-poor-will.

COUES, 1878, p. 613; although no specimens of this bird were taken, its unmistakable notes were heard every night in June at Pembina, assuring him of its presence in numbers in the heavy timber of the river bottom. This locality is very near its northern limit and it probably is not found any distance west of the Red River. ABBOTT, 1880, p. 984; heard on one occasion at Pembina. BENDIRE, 1895, p. 146; the whip-poor-will occurs west to eastern North Dakota. JUDD, 1917, p. 19; Mr. Conners reported he both heard and saw this bird on his yard fence in Cando. FREEMAN, 1919, p. 13; rare summer resident, heard along Red River.

Alfred Eastgate records it from Larimore, Grand Forks County, June, 1912. I did not see or hear this species at Devils Lake or the Turtle Mountains.

165. *Phalænoptilus nuttalli* (Audubon). Poor-will.

HAYDEN, 1863, p. 157; though rarely seen, this bird seems to be generally distributed throughout the Upper Missouri country. COUES, 1893, p. 171; Lewis and Clarke caught a whip-poor-will of a small and uncommon kind, October 17, 1804. In a foot-note Coues says that this is the bird first named and described by Audubon, Orn. Biog., V. 1839, page 335 as *Caprimulgus nuttalli*, or Nuttall's whip-poor-will. BENDIRE, 1895, p. 153; poor-will ranges to southern North Dakota. RIDGWAY, 1914, p. 550; northwest North Dakota.

While at Medora, June 14-23, this bird was heard a few evenings, giving its peculiar call, but none were seen.

166. *Chordeiles virginianus virginianus* (Gmelin). Nighthawk.

COUES, 1878, p. 613; occurs in summer throughout the whole region surveyed and is in most places very common. JUDD, 1917, p. 19; common summer resident. FREEMAN, 1919, p. 13; very common summer resident, May 22.

The species was not found at any of the localities visited except Cando, Towner County, where a typical one was taken, June 3, 1921.

167. *Chordeiles virginianus henryi* Cassin. Western Nighthawk.

ALLEN, 1874, p. 62; everywhere quite common. COUES, 1878, p. 138; the birds of the arid Missouri region are referable to the variety *henryi*. HOFFMAN, 1882, p. 401; common until the 20th of September. JUDD, 1917, p. 20; intermingling and breeding with *virginianus*.

168. *Chordeiles virginianus sennetti* Coues. Sennett's Nighthawk.

BISHOP, 1896, pp. 134-135; a series of ten adult male nighthawks [now in the American Museum] from Towner and Rolette counties, North Dakota, all closely resemble the type specimen, Number 4927 from the George B. Sennett Collection. RIDGWAY, 1914, p. 569; Fort Union, Pembina, Fort Rice, Towner County, Devils Lake, Indian Reservation, Pierce County, Rolette County and Nelson County, Fort Berthold, North Dakota.

Specimens taken in Ransom, Ramsey, Bottineau, and Williams counties were referred to this species by the writer, who believes it to be the predominating nighthawk in North Dakota.

All the nighthawks are very beneficial, living principally on mosquitoes.

169. *Chaetura pelagica* (Linnæus). Chimney Swift.

ALLEN, 1875, p. 62; common along the Missouri at Fort Rice, June, 1873. COUES, 1878, p. 614; common at Pembina and westward only to the Mouse River. Specimens taken at Pembina, June 2 to 24, and Mouse River, August 27, 1873. HOFFMAN, 1882, p. 401; saw no specimens in September, though nests were found in several places. JUDD, 1917, p. 20; a rare straggler, does not occur every year. FREEMAN, 1919, p. 13; common summer resident, Fargo, April 27.

At Devils Lake this species was first seen on May 20, 1921, and throughout the summer, as a pair nested in the big chimney of the station. This was the only locality I noted for the species, which is no doubt rare over most of the state.

170. *Archilochus colubris* (Linnæus). Ruby-throated Hummingbird.

COUES, 1878, p. 614; quite common at Pembina, not seen west of this point. Male taken June 5, 1873. JUDD, 1917, p. 20; not uncommon on prairies. Common and breeds in the Turtle Mountains. FREEMAN, 1919, p. 13; common summer resident.

This species was not rare after May 20, 1921, and is quite generally distributed over the state.

171. *Tyrannus tyrannus* (Linnæus). Kingbird.

COUES, 1878, p. 608; extremely numerous at Pembina. Specimens taken from June 2 to June 28, 1873. JUDD, 1917, p. 20; a very common summer resident.

The species was common after May 20, 1921, at Devils Lake, and was found in numbers in all parts of the state visited.

172. *Tyrannus verticalis* Say. Arkansas Kingbird.

COUES, 1897, p. 56; Audubon says on June 25, 1843, Harris brought in several Arkansas flycatchers (kingbird) at Fort Union: p. 86; on July 13 Audubon shot seven

Arkansas flycatchers. JUDD, 1917, p. 20; rare at Cando and north up to 1895. In 1910 they equalled the kingbird in numbers. FREEMAN, 1919, p. 13; a very common summer resident.

At Devils Lake this species was very common after May 14, 1921, and also occurred in numbers from Bottineau up to the edge of the Turtle Mountains, where it was not found. On July 24 it was not rare at Grafton.

173. *Myiarchus crinitus* (Linnæus). Crested Flycatcher.

JUDD, 1917, p. 20; rare, several specimens have been taken in the Turtle Mountains. FREEMAN, 1919, p. 13; not a common summer resident; seen along the Red River.

There is a mounted one in the Williams Collection taken at Grafton May 1, 1920. This species was seen but once, July 21, 1921, on the banks of the Red River south of Grand Forks.

174. *Sayornis phoebe* (Latham). Phoebe.

COUES, 1878; does not list this species. JUDD, 1917, p. 20; rare, but one specimen for this locality, April, 1895. FREEMAN, 1919, p. 13; occasional summer resident; April 3.

At Grafton Mr. Henry Williams has a nest and set of eggs taken from under a small bridge in the woods near that place in 1921. It has been noted at Anselm by William Shunk, a local bird student.

This species was seen about the store-house in the Rock Island Military Reservation at Devils Lake, May 7, 1921. No doubt it is rare in the state.

175. *Sayornis sayus* (Bonaparte). Say's Phoebe.

BAIRD, 1858, p. 186; one taken near Fort Union, August, 1856, by Dr. Hayden. HAYDEN, 1863, p. 158; it is quite rare among the ravines of the Bad Lands. ALLEN, 1875, p. 61; a few pair seen nesting in the Bad Lands and later small flocks of four or five were seen. COUES, 1878, p. 610; not observed in the Red River region, first noted at Fort Berthold in 1874. COUES, 1897, p. 16; on June 7, 1843, Audubon reported he saw Say's flycatcher near Mandan.

At the Agricultural College I saw a mounted specimen from Kenmare, collected July 17, 1913, by W. B. Bell.

This species was found only in the extreme west portions of North Dakota. It was first seen June 16, 1921, near Medora on the "Peaceful Valley Ranch," owned by the Honorable Carl Olsen. In ten days of field work here I saw but one, but at Williston, about seventy-five miles north, I found it to be more common and saw several on July 8, 1921.

176. *Nuttallornis borealis* (Swainson). Olive-sided Flycatcher.

HOFFMAN, 1882, p. 401; from Fort Berthold, McLean County, September, 1881.

I did not see this species in life, but there were fine mounted males and females in the Williams Collection, taken at Grafton, June 7, 1908. Mr. Russell Reid writes me as follows: "I found a dead one in Stony Point Slough, four miles northeast of Driscoll, Burleigh County, on September 22, 1917."

177. *Myiochanes richardsoni richardsoni* (Swainson). Western Wood Pewee.

COUES, 1878, p. 610; only noticed at Pembina, which is probably at or near its northwestern limit. A male was taken June 6, 1873. RIDGWAY, 1907, p. 523; nested in Rolette and Nelson counties, North Dakota. JUDD, 1917, p. 20; admitted to list, but data on this species is very incomplete. FREEMAN, 1919, p. 13; common summer resident, May 26.

At Devils Lake I first noted this species June 9, 1921, and it was only occasionally seen there later.

178. *Empidonax flaviventris* (W. M. and S. F. Baird). Yellow-bellied Flycatcher.

RIDGWAY, 1907, p. 550; breeding at Stump Lake, North Dakota. JUDD, 1917, p. 20; rare, breeding in Turtle Mountains.

I do not know of any other records for this species.

179. *Empidonax trailli trailli* (Audubon). Traill's Flycatcher.

COUES, 1878, p. 611; found this species common at Pembina during the first week in June, but not later than the 9th. Specimens were taken June 2 to 9, 1873. JUDD, 1917, p. 21; common migrant in the prairie region, breeds in Turtle Mountains; earliest migrants, May 8.

I first noted this species May 30, at Devils Lake and again at Cando, June 2, where it was quite common around Mr. Judd's grove. One was secured at Snyder Lake, Towner County, June 4, 1921. In 1921 several were seen at the Turtle Mountains, August 3 to 7.

180. *Empidonax trailli alnorum* Brewster. Alder Flycatcher.

RIDGWAY, 1907, p. 559; breeding at Pembina and in Towner County.

This is the only record known to the writer.

181. *Empidonax minimus* (W. M. and S. F. Baird). Least Flycatcher.

ALLEN, 1875, p. 62; common in the bottom lands of the Missouri at Fort Rice, 1873. A few were also seen on Heart River. COUES, 1878, p. 611; very abundant at Pembina, and found also in the Turtle Mountains, beyond which it was not seen. Specimens were secured at Pembina, June 2 to 24, 1873, and at the Turtle Mountains, August 8. Eggs were found June 13, 1873. HOFFMAN, 1882, p. 401; appeared to be common during the first part of September at Fort Berthold. JUDD, 1917, p. 21; tolerably common summer resident of Turtle Mountains and woods around Devils Lake. First seen June 4; eggs were found June 29.

I found this species common at Devils Lake after May 20, 1921, and at all the localities visited, even in small groves on the prairies. Like the other flycatchers, it is very beneficial, as it destroys many injurious insects.

182. *Otocoris alpestris praticola* Henshaw. Prairie Horned Lark.

JUDD, 1917, p. 21; tolerably common summer resident. FREEMAN, 1919, p. 13; permanent resident, nests before the last snows are gone.

Many horned larks were seen all over the state and some in the eastern part were noted as this species.

183. *Otocoris alpestris leucolæma* (Coues). Desert Horned Lark.

COUES, 1878, pp. 555-557; from the Red River west to the Rocky Mountains it breeds in profusion and during the greater part of the year is the most abundant and characteristic species of the prairie avifauna. Specimens were taken at Mouse River September 12 and October 1, 1873. HOFFMAN, 1882, p. 400; secured a number of specimens in the grassy areas near the stubble fields. It is more common after the 15th of September. COOKE, 1888, p. 156; breeds in North Dakota as far east as Devils Lake. COUES, 1897, p. 57; Audubon says on June 27, Harris shot two of what he calls the small shore lark, near Fort Union. RIDGWAY, 1907, p. 309; breeding in North Dakota. LARSON, 1913, p. 94; in McKenzie County becomes common in February after the first few warm days. JUDD, 1917, p. 21; this light-colored form is more common than *praticola*, but does not appear in the spring migrations until much later.

At Devils Lake I saw two birds which I referred to this species on May 6, 1921, but it was not as common as on the open prairies. At Medora it was almost the only bird seen on the high, barren prairies. It was also common at Williston and Bottineau.

184. *Otocoris alpestris hoyti* Bishop. Hoyt's Horned Lark.

BISHOP, 1896, p. 130; the type is an adult male, No. 1447, Cando, Towner County, North Dakota, April 22, 1895. L. B. B., collection of L. B. Bishop. LARSON, 1913, p. 94; occasionally seen during the winter in McKenzie County. JUDD, 1917, p. 21; common in flocks in late fall and late winter migrations, but classed as a winter resident. REID, 1921, p. 6; frequent during the winter months.

A mounted specimen is in the Williams Collection, but the species was not seen alive.

185. *Otocoris alpestris enthymia*[6] Oberholser. Saskatchewan Horned Lark.

REID, 1921, p. 6; abundant in the fall and late winter, a few are probably with us throughout the year.

Mr. Russell Reid has given the author a photograph taken June 6, 1921, near Bismarck, of a female of this species on her nest. (See Plate III.)

186. *Pica pica hudsonia* (Sabine). Magpie.

BAIRD, 1858, p. 578; male taken at Fort Berthold, 1856, by Dr. Hayden. ALLEN, 1875, p. 61; not common. COUES, 1878, p. 607; no magpies seen in the Red River region. HOFFMAN, 1882, p. 400; rare, saw two individuals in the Bad Lands seven miles east of Fort Berthold about the 20th of September. COUES, 1893, p. 251; Lewis and Clark sent four magpies alive to President Jefferson from Fort Mandan on April 4, 1805; on April 14 they saw a number of magpies which built their nests of sticks in trees. COUES, 1897, p. 58; Audubon says on June 27, 1843, Bell saw some magpies: p. 63; on June 25, Squires saw a great many about 15 miles from Fort Union. RIDGWAY, 1904, p. 290; breeding at Fort Berthold, McLean County. THWAITES, 1906, p. 31; on July 9, 1833, Maximilian records killing his first magpie near Fort Union: p. 215; on November 5, 1833, he saw many magpies, one so tame it settled on the rudder of the boat. LARSON, p. 94; a common resident, will eat any kind of flesh. BAILEY, 1918, p. 176; has been recorded at Creel Bay, Devils Lake, which is its eastern limit. FREEMAN, 1919, p. 13; sometimes a winter visitor, seen near Casselton and Leonard, Cass County.

[6] Oberholser, *Proc. U. S. Nat. Mus.*, XXVI, June 9, 1902, pp. 807-817. (Revised as a subspecies) *Auk*, Vol. XXXVI, 1919, p. 269.

The Williams Collection contains a mounted specimen taken at Grafton January 2, 1918, and there is another Grafton record of December 18, 1920. At Bisbee, Towner County, I saw a mounted bird taken in the Turtle Mountains. The species was seen in the field only at Medora, June 14, 1921.

A family of five had wintered in the oak forest on the Rock Island Military Reservation at Devils Lake, 1920-21, where they were frequently seen by Captain Lonnevik. They were seen also as late as April, 1921, by Mr. Way at his home on the west side of Creel Bay, Devils Lake. Mr. Alfred Eastgate reports that they have become more common in the eastern part of the state since 1911. It is probable that they range as far east as the Red River.

In the Museum of Zoology are eight specimens sent in the flesh from Fort Totten, North Dakota, taken January and February, 1922, by F. W. Triska.

The species is considered very injurious, as it destroys eggs and young birds of all kinds, including poultry. I was also told of many instances where they had eaten great holes on the backs of living sheep, cattle and horses.

187. *Cyanocitta cristata cristata* (Linnæus). Blue Jay.

COUES, 1878, p. 607; not seen west of Pembina, where it was very abundant. Specimens were taken June 2, 1873. JUDD, 1917, p. 21; tolerably common migrant of the prairies; nests in some numbers in the Turtle Muontains.

On August 14, 1920, a family of five were seen at the water tank on the Rock Island Military Reservation. A few are said to winter in the vicinity. In 1921 the species was first seen on May 19 near the home of Mr. Way on the west side of Creel Bay. On July 13, 1921, one was seen near Bottineau, my most northern and western record for the species. It was quite common along the Red River at Grand Forks, July 21, 1921. A specimen in the Museum of Zoology was taken February 20, 1922, at Fort Totten by F. W. Triska.

It is an injurious species, destroying many bird eggs and young birds.

188. *Perisoreus canadensis canadensis* (Linnæus). Canada Jay.

JUDD, 1917, p. 21; rare, found both summer and winter in Turtle Mountains.

The species was not seen in the field. Mr. Alfred Eastgate reports that they bred in the Turtle Mountains in 1902 and were common during the winter. He also saw them at Stump Lake in October, 1912. A mounted specimen with no data is in the University of North Dakota Museum. One in the Williams Collection was taken at Grafton, May 30, 1920. Mr. Henry Williams told me that they came to Grafton for the first time November 28, 1919, and had been quite common since.

189. *Corvus corax principalis* Ridgway. Northern Raven.

ALLEN, 1875, p. 61; more or less common from the Missouri to Montana, being seen almost daily. COUES, 1878, p. 607; occasionally observed. HOFFMAN, 1882, p. 400; but rarely seen during my stay at Fort Berthold, September, 1882. S. C. C., 1887, p. 414; ravens occur near Bismarck. COUES, 1897, p. 28; Audubon says at Fort

Union on June 12, 1843, he saw a wolf drive four ravens away from a sand-bar: p. 80: July 7, he shot one near the Fort. THWAITES, 1906, p. 212; November 2, 1833, below Fort Union, Maximilian saw ravens along the Missouri River. JUDD, 1917, p. 21; very rare, if it occurs at all. FREEMAN, 1919, p. 13; has been reported at Fargo.

There is a mounted specimen in the museum of Fargo College. Mr. Henry Williams saw one at Grafton, June 15, 1921, and Mr. Alfred Eastgate in a recent letter tells of a raven killed in the Turtle Mountains, November, 1883.

Apparently, this is an extremely rare species in North Dakota at the present time.

190. *Corvus brachyrhynchos brachyrhynchos* Brehm. Crow.

COUES, 1878, p. 606; not very common in the region, though there were a good many along the Mouse River. COUES, 1897, p. 36; June 15, Audubon says both the common crow and raven are found at Fort Union. (This is the only North Dakota record noted by Audubon, and it may have been the western species, *hesperis*, as it occurs in Montana.) THWAITES, 1904, p. 141; H. M. Breckenridge reports seeing crows on the Upper Missouri in the summer of 1811. JUDD, 1917, p. 21; a tolerably common summer resident.

The species was found to be quite common at Devils Lake and in all parts of the state visited. The status of this bird is in much dispute, for while it no doubt does much damage to nesting birds, it also eats many injurious insects and mammals. I consider it on the whole injurious.

191. *Corvus brachyrhynchos hesperis* Ridgway. Western Crow.

HOFFMAN, 1882, p. 400; found singly and in small flocks the early part of September, but about the 20th large flocks were seen flying over the village and down the river. RIDGWAY, 1904, p. 271; breeding; specimens from Souris River.

The crows seen in western North Dakota are no doubt referable to this subspecies, as it is common in Montana.

192. *Nucifraga columbiana* (Wilson). Clarke's Nutcracker.

The Williams Collection contains a mounted specimen taken at Bottineau September 17, 1919, by W. R. McIntosh. I heard of one in the Bad Lands along the Little Missouri River near Medora. This species must be considered as a rare straggler in North Dakota, although common in the mountains of Montana.

193. *Dolichonyx oryzivorus* (Linnæus). Bobolink.

COUES, 1878, pp. 599, 600; at Pembina in June bobolinks were breeding in large numbers on the open prairie adjoining the river. The species was traced westward quite to the Rocky Mountains. Specimens were taken at Pembina, June 5 to July 8, and Mouse River, August 16, 1873. COUES, 1897, p. 86; July 13, Audubon saw a flock of fifteen or twenty bobolinks and shot a male near Fort Union. JUDD, 1917, p. 21; common summer resident.

This species was rather common throughout the region studied, except at Medora and the Turtle Mountains.

194. *Molothrus ater ater* (Boddaert). Cowbird.

COUES, 1878, p. 600; nowhere found the cowbird more abundant than it is in summer throughout the region surveyed. Specimens were taken at Pembina, June 4

to July 8, 1873, and at Mouse River, August 9 and 22, 1873. HOFFMAN, 1882, p. 399; rather abundant and associated with flocks of red-winged and yellow-headed blackbirds. JUDD, 1917, p. 21; abundant summer resident.

Found in all parts of the state worked. It is a great menace to all small bird life because of its parasitical habit.

195. *Xanthocephalus xanthocephalus* (Bonaparte). Yellow-headed Blackbird.

ALLEN, 1875, p. 60; seen but three or four times in the whole journey. A small colony was found breeding near the point where they crossed the Big Muddy, Morton County, 1873. A small flock was seen once on the Heart River. COUES, 1878, p. 602; at Pembina, breeding abundantly in the prairie sloughs the last week in June. Specimens were taken at Pembina, June 17 to 27, Turtle Mountains, August 2, and Mouse River, August 13 to 22, 1873. HOFFMAN, 1882, p. 399; common in September. JUDD, 1917, p. 21; abundant summer resident, nests in colonies.

It occurs throughout the state in suitable habitats and is no doubt a very beneficial species. It was not common at Devils Lake, where it was first seen May 31, 1921. Later, on June 4, I saw a large colony near St. Johns, Rolette County. A specimen collected at Sweetwater Lake, Ramsey County, August 11, 1900, by Charles L. Cass is in the Museum of Zoology Collection, also a set of three eggs collected there May 30, 1900.

196. *Agelaius phoeniceus fortis* Ridgway. Thick-billed Red-wing.

COUES, 1878, p. 602; found only at Pembina, where it was not very common; a male and a female were taken there June 19, 1873. HOFFMAN, 1882, p. 400; abundant and associated with the two preceding species. COUES, 1897, p. 90; July 15, Audubon shot a common red-winged starling near Fort Union. OBERHOLSER, 1907, p. 335; male from Pembina, taken June 19, 1873. JUDD, 1917, p. 21; common summer resident. FREEMAN, 1919, p. 14; very common summer resident.

All the above listed notes were given under the eastern species name, *phoeniceus phoeniceus*, but *fortis* is doubtless the only one in North Dakota. Mr. Russell Reid writes that he collected this species May 9, 1920, at Bismarck and sent it to the United States Biological Survey, where it was determined by H. C. Oberholser as the thick-billed red-wing.

It was found to be rather common at all the places visited. The earliest record was May 9, 1921, at Devils Lake. It was not as common at Bottineau as Brewer's blackbird.

197. *Sturnella neglecta* Audubon. Western Meadowlark.

BAIRD, 1858, p. 539; a male from Fort Union taken June 30, 1843, by J. J. Audubon. COUES, 1878, p. 603; all the meadow larks observed in this region, where the fauna is so thoroughly eastern, were typical *neglecta*. Specimens were taken June 5 to 30 at Pembina and July 20 to August 2, 1873, at Turtle Mountains. HOFFMAN, 1882, p. 400; but two individuals observed. COUES, 1897, p. 67; June 29, Audubon killed a female meadow lark [near Fort Union], the first noted in this country.

This species was common and generally well distributed over the state. An egg in the Museum of Zoology Collection was taken June 14, 1900, by Charles L. Cass near Sweetwater Lake. It is a very beneficial bird, destroying numerous quantities of injurious insects. Its song is different, but no more beautiful than that of the eastern bird.

198. *Icterus spurius* (Linnæus). Orchard Oriole.

ALLEN, 1875, p. 60; a few pair seen near the second crossing of the Heart River, July 5, 1873, were the only ones met with. COUES, 1878, p. 604; one specimen at Pembina, the only locality where it was observed, June 6, 1873. ABBOTT, 1880, p. 984; not common near Pembina in July, 1879. RIDGWAY, 1902, p. 276; southern North Dakota. JUDD, 1917, p. 21; rare on the prairie, found breeding around the large lakes to the south; not found in the Turtle Mountains. FREEMAN, 1919, p. 14; rare.

The species was not seen in life, but there is a mounted specimen in the Agricultural College Museum taken at Hankinson, Richland County, July 23, 1912, by W. B. Bell, and another in the Williams Collection taken at Grafton, July 30, 1904. Mr. Russell Reid found a nest on July 20, 1919, and saw three birds June 4, 1921, near Bismarck.

199. *Icterus galbula* (Linnæus). Baltimore Oriole.

COUES, 1878, p. 604; abundant at Pembina, the only locality where it was found. Specimens were taken from June 2 to July 8, 1873. ABBOTT, 1880, p. 984; generally common at Pembina in July, 1879. JUDD, 1917, p. 22; tolerably common migrant over prairies, nesting in timber on shores of large lakes and in the Turtle Mountains. FREEMAN, 1919, p. 14; a common summer resident, May 14.

This was a very common species at Devils Lake after May 20, 1921, and it was found in all the localities worked, although it was more common in the eastern part of the state. The orioles are very beneficial in their food habits.

200. *Icterus bullocki* (Swainson). Bullock's Oriole.

ALLEN, 1875, p. 60; more or less frequent along all the wooded portions of the streams. Observed at Fort Rice in 1873, and on the Heart River. BENDIRE, 1895, p. 486; Bullock's oriole ranges east to western North Dakota. SCHMIDT, 1920, p. 313; central North Dakota.

This species is not noted in many of the state lists, and it was with pleasure that I secured a pair of these birds in a small grove of cottonwoods at the edge of the town of Medora on June 14, 1921. These were the only ones seen, although I worked in the region for ten days.

201. *Euphagus carolinus* (Müller). Rusty Blackbird.

COUES, 1878, p. 605; enters Dakota from the north in September. THWAITES, 1905, p. 385; Maximilian records seeing this species at Fort Union, June 24, 1833. JUDD, 1917, p. 22; very common migrant, arrives the first week in May. FREEMAN, 1919, p. 14; transient visitant, April 22.

At Grafton it was nesting commonly at the edge of small sloughs along the railroad north of the city. Mr. Williams said he had found many nests at that place. At the time of my arrival, July 24, the young were flying with the adults.

202. *Euphagus cyanocephalus* (Wagler). Brewer's Blackbird.

ALLEN, 1875, p. 60; immense flocks in September, 1873, along the Heart and James rivers. COUES, 1878, p. 605; the characteristic blackbird of the whole region in summer. Hundreds spend this season at Fort Pembina and it is no less common a Fort Buford. Specimens were taken at Pembina, June 14 to 24, and at Mouse

River, September 16 to October 3, 1873. HOFFMAN, 1882, p. 400; several specimens from the flocks of blackbirds. COUES, 1897, p. 48; Audubon says Harris and Bell brought in three or four blackbirds nearly allied to the rusty grackle, but with a much shorter and straighter bill. Dr. Coues in a foot-note says this is *Quiscalus brewerí* of Audubon. It was new to our fauna when thus dedicated to his friend, Dr. Thomas M. Brewer, of Boston, but had already been described by Wagler from Mexico as *Psarocolius cyanocephalus*. JUDD, 1917, p. 22; a few pair usually breed on the outskirts of the Turtle Mountains.

I first saw this species in the Turtle Mountains on June 5, 1921; later, June 14, I found it to be common at Medora. The second week in July it was seen at Bottineau. Numbers of adults and young were at Grafton, July 24 and 25, 1921, and Mr. Williams told me that the species nested commonly near the town.

203. *Quiscalus quiscula æneus* Ridgway. Bronzed Grackle.

COUES, 1878, p. 606; abundant at Pembina, where it was breeding in June in the hollows of trees. Occurred sparingly along Mouse River in the fall, October 3, 1873, and at Pembina, June 4 to 22, 1873. HOFFMAN, 1882, p. 400; several flocks pass across the village each day from the agency fields to the ponds of water west of the settlement. JUDD, 1917, p. 22; tolerably common summer resident.

It was common at Devils Lake after May 3, 1921, and also throughout the state. On July 11, 1911, Mr. Henry Williams shot a bird at Bottineau that had a band on the leg (No. 431). This species, like all the blackbirds, is very beneficial in its food habits.

204. *Hesperiphona vespertina vespertina* (W. Cooper). Evening Grosbeak.

JUDD, 1917, p. 22; rare straggler, only two or three records in a number of years in early spring. FREEMAN, 1919, p. 14; irregular winter visitant. Fairly common the last few years in January, February, and March.

There is a mounted specimen in the Agricultural College Museum and one in the Williams Collection, both taken at Grafton, December 20, 1908, by Henry Williams, who reports that the species is common each winter, feeding on the seeds of the box elder.

205. *Pinicola enucleator leucura* (Müller). Pine Grosbeak.

JUDD, 1917, p. 22; irregular winter visitant in small flocks. FREEMAN, 1919, p. 14; rare winter visitant, April 2.

The only specimens I saw with data were in the Williams Collection, and a female in the Agricultural College Museum at Fargo, both taken at Grafton, January 4, 1910, by Henry Williams.

206. *Carpodacus purpureus purpureus* (Gmelin). Purple Finch.

COUES, 1874, p. 106; found breeding in the Turtle Mountains, North Dakota, in July. COUES, 1878, p. 577; found in small numbers in the Turtle Mountains during the latter part of July; doubtless breeds in this locality; a female was taken July 28, 1873. JUDD, 1917, p. 22; rarely seen on the prairies. Breeds in the Turtle Mountains.

The Williams Collection contains a mounted specimen taken at Grafton, May 27, 1909.

207. *Loxia curvirostra minor* (Brehm). Crossbill.

JUDD, 1917, p. 22; rare visitor, a juvenile specimen taken in August, 1891.

The only specimen I saw with data was in the Williams Collection, taken at Grafton, June 18, 1910, by Mr. Williams. Mr. Russell Reid, in a letter of January 4, 1922, says he saw the American crossbill at Bismarck in September, 1919.

208. *Loxia leucoptera* Gmelin. White-winged Crossbill.

JUDD, 1917, p. 22; small flock seen in latter part of July, 1895.

There is a mounted specimen in the Williams Collection taken at Grafton, July 23, 1905, and one in the Agricultural College Museum at Fargo, labelled November 1, 1919, J. H. Phelps. Professor Daniel Freeman, of Fargo College, has written me that in January, 1919, a flock of five to seven were seen along the Red River. Mrs. Dana Wright, of Jamestown, in a letter to Professor Freeman tells of the species nesting in late May and early June, 1894, near Jamestown. Mrs. Wright reports further that they nested there for several years afterward, in the box elder trees, where she saw one May 10, 1921.

209. *Acanthis hornemanni exilipes* (Coues). Hoary Redpoll.

JUDD, 1917, p. 23; rare winter visitant, usually found in flocks of the common redpoll.

The species was not seen in the field, nor are there specimens in the state collections.

210. *Acanthis linaria linaria* (Linnæus). Redpoll.

SCHMIDT, 1904; a migrant, all sections. THWAITES, 1906, p. 209; October 31, 1833, Maximilian records flocks of redpolls near Fort Union, Williams County, also at Fort Clarke in winter. LARSON, 1913, p. 94; rare, two seen February 8, 1913, northern McKenzie County. JUDD, 1917, p. 23; common winter visitant and migrant in spring and fall. FREEMAN, 1919, p. 14; common winter visitant at Fargo.

There is a specimen in the Williams Collection labelled January 6, 1914. It seems to be a common winter resident.

211. *Astragalinus tristis tristis* (Linnæus). Goldfinch.

COUES, 1878, p. 577; noted only at Pembina; a male taken June 4, 1873. JUDD, 1917, p. 23; tolerably common, breeds in the Turtle Mountains. FREEMAN, 1919, p. 14; very common in timber and weeds, May 14.

I saw the species at Devils Lake on May 25 and found it to be quite common throughout the state.

212. *Spinus pinus* (Wilson). Pine Siskin.

The Williams Collection contains a specimen taken May 21, 1914, and Mr. Reid writes me that he saw four on the State Capitol grounds on May 24, 1921. I saw a small flock or family near Lake Upsilon, Turtle Mountains, on August 3, 1920; these were the only ones noted in life.

213. *Plectrophenax nivalis nivalis* (Linnæus). Snow Bunting.

THWAITES, 1906, p. 233; at Fort Clarke in winter of 1833-4, Maximilian saw flocks feeding on seeds of grass. LARSON, 1913, p. 94; common in winter on the prairies in McKenzie County, gathering in immense flocks. JUDD, 1917, p. 23; abundant migrant; winter resident some years; usually arrives from the north early in October and last seen early in May.

Two mounted specimens were examined, one in the Williams Collection with the date of December 24, 1906, and one without data in the Agricultural College Museum.

214. *Calcarius lapponicus lapponicus* (Linnæus). Lapland Longspur.

COUES, 1878, p. 578; a single specimen secured at Mouse River, October 1, 1873. LARSON, 1913, p. 94; occasionally seen during the winter, but becomes more common in February in McKenzie County. JUDD, 1917, p. 23; abundant migrant, seen in flocks of hundreds both in spring and fall.

The Williams Collection contains mounted specimens taken March 15 and April 22, 1913, at Grafton, and the Museum of Zoology contains a male and female collected at the same place, on March 15, 1913, by H. V. Williams.

215. *Calcarius pictus* (Swainson). Smith's Longspur.

COUES, 1878, p. 579; observed only on one occasion in company with the chestnut-collared and Lapland longspurs at Mouse River. A male and a female were taken October 1, 1873. JUDD, 1917, p. 23; common migrant, usually feeding on stubble; not often seen on the grass of the prairie or in the wooded sections.

The Williams Collection contains a bird labelled October 5, 1914, taken at Grafton.

216. *Calcarius ornatus* (J. K. Townsend). Chestnut-collared Longspur.

BAIRD, 1858, p. 435; a male taken at Fort Union, June 21, 1843, by J. J. Audubon. ALLEN, 1875, p. 55; abundant from Fort Rice on the Missouri River to the Yellowstone. COUES, 1878, p. 579; not noticed in the valley of the Red River, but found in profusion after passing to the westward of the Pembina Mountains to the Rockies. Many taken from July 14 to September 8 in North Dakota. HOFFMAN, 1882, p. 398; apparently not rare, noticed in the stubble-fields, middle of September. CURRIE, 1892, pp. 243-244; first observed April 22, and sets of eggs found from the last of May to July 30. I think two broods are raised each season. In Ramsey County this species is associated with McCown's longspur. ABBOTT, 1916, No. 94, p. 3; encountered everywhere throughout Pierce and Benson counties.

This species was breeding commonly in the prairies about Cando, June 2, and north to the United States boundary line, June 4, 1921. They were not seen in the Devils and Stump lakes region nor on the prairies about Medora, but at Williston, seventy-five miles north, many were found on July 8, and about Bottineau, July 10 to 17, they were very common. On July 11 I saw a nest with five young birds, fourteen miles west of Bottineau, built in a wheat field at the edge of a state road. Most of the nests were found in old prairie pastures or along the side of the road, where the males were very conspicuous, soaring near the nesting site and singing as they soared, then dropping to the ground with set wings.

217. *Rhynchophanes mccowni* (Lawrence). McCown's Longspur.

ALLEN, 1875, p. 56; in considerable abundance from the Missouri to the Yellowstone. In September, 1873, the prairies were alive with immense flocks, some of thousands of individuals. HOFFMAN, 1882, p. 398; less common than the preceding species. ABBOTT, 1916, p. 3; less common, but its song more pleasing than the chestnut-collared longspur. JUDD, 1917, p. 23; has become more and more rare as the country has settled, until now, 1910, it is rarely seen. FREEMAN, 1919, p. 14; transient visitant, May.

This species was not observed in life, although I visited the high, dry prairie benches which it prefers. Mr. Eastgate, of Bottineau, told me that it bred west of the Mouse River in the northwestern part of North Dakota. In the Museum of the Agricultural College at Fargo I saw a skin taken at Sentinel Butte, August 4, 1913, by W. B. Bell, and there is a skin in the Museum of Zoology Collection from Chief Mountain, North Dakota, August 15, 1874, collected by Dr. Elliott Coues.

All of the longspurs are very beneficial and destroy great quantities of weed seeds and injurious insects.

218. *Proecetes gramineus confinis* (Baird.) Western Vesper Sparrow.

COUES, 1878, p. 589; extends over the whole region explored. Specimens were taken at Pembina, June 5 to 19; Turtle Mountains, July 20 to August 2; Mouse River, August 30; and Long Coteau River, September 8, 1873. HOFFMAN, 1882, p. 398; rather common, many killed by the Indian boys with bow and arrows at Fort Berthold in September. COUES, 1897, p. 21; on June 9 Harris and Bell shot some bay-winged buntings near the mouth of the Little Missouri. RIDGWAY, 1901, p. 184; breeding in middle North Dakota. JUDD, 1917, p. 23; intermingling with the true vesper, if not confounded at times with it.

This was a common species at Devils Lake on my arrival, May 3, 1921, and later at all the localities worked. It is a very beneficial species in its food habits.

219. *Passerculus sandwichensis alaudinus* Bonaparte. Western Savannah Sparrow.

COUES, 1878, p. 588; breeds in profusion throughout the region. Specimens were taken at Pembina, June 2 to 14; Turtle Mountains, July 20 to August 8; and Mouse River, September 27, 1873. JUDD, 1917, p. 23; common summer resident, nesting in all suitable localities.

At Devils Lake this was a common breeder, especially fond of the vicinity of water. It was not seen at Medora or Williston, but was at Bottineau on July 11, 1921.

220. *Ammodramus bairdi* (Audubon). Baird's Sparrow.

BAIRD, 1858, p. 441; records the type, taken at Fort Union, Williams County, July 26, 1843, by J. J. Audubon. ALLEN, 1875, p. 57; rather frequent in the moist hollows from the Missouri westward to the Little Missouri. A single nest, the first one known, was found July 1, near Heart River. It was of dry grass, placed on the ground, and contained four eggs. COUES, 1878, p. 585; not met with along the Red River, but from the Pembina Mountains to the prairie beyond, in some particular spots it outnumbered all the other birds together. First taken July 14, 1873, twenty miles west of Pembina Mountains and from there to the Mouse River, October 1, 1783. COUES, 1897, p. 116; Audubon says on July 26, 1843, Bell shot a male

and a female. Audubon named this species after his young friend, Spencer F. Baird. Coues says special interest attaches to this case, for the bird was not only the first one ever dedicated to Baird but was the last one named, described and figured by Audubon, and the plate of it completes the series of five hundred plates in his octavo edition of Birds of North America. BENT, 1901, p. 329; Baird's sparrows were scattered about over the prairie. ABBOTT, 1916, No. 94, p. 4; a weedy stretch of prairie was the one place where Baird's sparrows were common; there were a dozen trilling males in the space of forty acres. JUDD, 1917, p. 23; common summer resident.

The Agricultural College Museum has a bird without data, and the Williams Collection contains one collected October 7, 1914.

On June 4, 1921, Mr. Elmer Judd and I made a long trip by automobile north from Cando to Snyder, Rock, and other small lakes. We were in quest of this species, but it was not until passing many of their old haunts that we at last found a male singing by the roadside near St. Johns. From here we drove north to the United States boundary line, and there saw our second bird. These were the only specimens seen by me in life.

221. *Ammodramus savannarum bimaculatus* Swainson. Western Grasshopper Sparrow.

ALLEN, 1875, p. 57; common at intervals from the Missouri to Montana. BAILEY, 1916, p. 16; mentions the song of the grasshopper sparrow in the Devils Lake region. JUDD, 1917, p. 23; not common, but probably breeds. FREEMAN, 1918, p. 14; fairly common summer resident.

In 1920 this species was seen but once, August 9, in a prairie pasture near Bottineau. On June 17, 1921, I secured a fine specimen on a high prairie plateau in the Bad Lands a few miles north of Medora.

222. *Passerherbulus henslowi occidentalis* (Brewster). Western Henslow's Sparrow.

ABBOTT, 1880, p. 984; found near Pembina, July, 1879. COUES, 1897, p. 4; Bell shot a bunting which resembles Henslow's, but we have no means of comparing it at present. SCHMIDT, 1904; nests in central and eastern part of the state. SCHMIDT, 1920, p. 320; summer resident.

The species was not seen in the field, nor are there specimens in any of the collections in the state that I examined.

223. *Passerherbulus lecontei* (Audubon). Leconte's Sparrow.

COUES, 1878, p. 587; a small colony was near the Mouse River on August 9, 1873, and with great difficulty five specimens were secured; later, September 9, the bird was found again and a sixth specimen secured at Long Coteau River. ABBOTT, 1880, p. 984; very common in sloughs near Pembina, July, 1879. ALLEN, 1886, pp. 489-490; as is well known, Leconte's sparrow was described by Audubon in his Birds of America, VII, p. 338, Pl. 488, from a specimen obtained on the Upper Missouri in 1843. Audubon says he procured several specimens and mentioned especially one, a fine male, shot by J. G. Bell on the 24th of May near Fort Union, North Dakota. A specimen in the Maximilian Collection in the American Museum of Natural History was no doubt taken by him on his sojourn at Fort Union ten years before. Audubon records this specimen as still in excellent condition. JUDD, 1917, p. 24; common migrant and thought to breed here.

In 1920 I collected an adult male and a juvenile on August 1. These were in a low meadow near the edge of Bluebill Lake, Turtle Mountains. On May 24, 1922, a fine female Leconte's sparrow was taken at Grafton by H. V. Williams.

224. *Passerherbulus nelsoni nelsoni* (Allen). Nelson's Sparrow.

COOKE, 1888, p. 192; Mr. Vernon Bailey has recently found it breeding at Devils Lake, North Dakota. ROLFE, 1899, pp. 356-357; on June 14, 1899, the first United States nest was taken with both birds and five eggs at Devils Lake, North Dakota. BOWMAN, 1904, pp. 385-386; a nest with five eggs and the pair of birds taken June 12, 1902, near the city of Devils Lake, North Dakota. ABBOTT, 1916, p. 4; a low, wheezy song is conspicuous, vibrating in waves through the still air of a June sunset, the vesper recital of Nelson's sharp-tail on the Big Coulee marsh. BAILEY, 1916, p. 20; a few yards away came a Nelson sparrow, giving his loud flight song. JUDD, 1917, p. 24; tolerably common migrant, but rarely seen.

The Agricultural College Museum at Fargo contains a male taken July 22, 1912, at Hankinson, Richland County, by W. B. Bell. The species was seen but once alive, on June 29, 1921, in a dry slough in Ransom County, where one male was taken while singing.

225. *Chondestes grammacus strigatus* Swainson. Western Lark Sparrow.

BAIRD, 1858, p. 457; male and female taken at Fort Union, June, 1843, by J. J. Audubon. ALLEN, 1875, p. 58; one of the most abundant and generally diffused species. HOFFMAN, 1882, p. 399; from Fort Berthold. SCHMIDT, 1904; western part of state. THWAITES, 1906, p. 52; Maximilian records it from the Upper Missouri, July 25, 1833. FREEMAN, 1910, p. 14; summer resident; May 9.

The species was found to be a common resident about Anselm, Ransom County, June 28-30, 1921, and at Medora it was very abundant about the prairie pastures from June 16 to 25, and at Williston on July 7. I also found it common at Grafton, July 23, 1921.

These scattered records indicate its general distribution throughout the state.

226. *Zonotrichia querula* (Nuttall). Harris's Sparrow.

COUES, 1878, p. 594; a fine series was secured at Mouse River in September and October. The species arrived from the north September 18, and specimens were taken October 3, 1873. JUDD, 1917, p. 24; common migrant, arriving about May 1 and September 10. FREEMAN, 1910, p. 14; common transient visitant, May 6, September 19.

The Museum of Zoology Collection contains one specimen taken at Grafton, May 9, 1913, and a series of six taken there from September 27 to October 9, 1921, by Henry Williams.

The species was usually found with the white-crowned sparrow. On May 8, 1921, a bird was seen at the Biological Station and there were others there as late as May 14. Mr. William Shunk gives me a record of one at Anselm, Ransom County, May 5, 1916.

227. *Zonotrichia leucophrys leucophrys* (J. R. Forster). White-crowned Sparrow.

HOFFMAN, 1882, p. 399; several seen near Fort Berthold. JUDD, 1917, p. 24; tolerably common migrant in spring. FREEMAN, 1919, p. 14; transient visitant, common April 25. SCHMIDT, 1920, p. 321; a migrant and occasional summer resident.

An immature male of this species taken at Grafton, October 14, 1921, by Henry Williams, is in the Museum of Zoology Collection. Mr. William Shunk gave me a record for Anselm of May 12, 1916. The species was seen and one taken at Devils Lake, May 12, 1921, but had passed north by May 25.

228. *Zonotrichia leucophrys gambel* (Nuttall). Gambel's Sparrow.

COUES, 1878, p. 594; the white-crowned sparrows of the Mouse River country were of this variety instead of typical *leucophrys*, as shown beyond question by some of the specimens taken with perfect head dress from September 18 to 30, 1873.

Mr. Russell Reid reported that a specimen collected at Bismarck, September 26, 1921, was identified as this species by Dr. H. C. Oberholser.

229. *Zonotrichia albicollis* (Gmelin). White-throated Sparrow.

HOFFMAN, 1882, p. 399; a single individual was procured by an Indian boy near the village of Fort Berthold. JUDD, 1917, p. 24; tolerably common migrant on prairies, breeding in the Turtle Mountains. FREEMAN, 1919, p. 14; common transient visitant, April 22. SCHMIDT, 1920, p. 317; common migrant and occasional summer resident.

A few individuals were seen at Devils Lake, August 20, 1920. In 1921 it was present there upon my arrival, May 4, and continued common until May 30.

230. *Spizella monticola ochracea* Brewster. Western Tree Sparrow.

COUES, 1878, p. 590; no tree sparrows were observed in summer, but one was taken at the Mouse River, October 5, 1873. JUDD, 1917, p. 24; common migrant, spring and fall.

The species was not seen in life, but there is a mounted specimen in the Agricultural College Museum taken at Grafton, October 28, 1912, by Henry Williams.

231. *Spizella passerina arizonae* Coues. Western Chipping Sparrow.

ALLEN, 1875, p. 57; more or less common along the streams from the Missouri to Montana. HOFFMAN, 1882, p. 399; not uncommon in the underbrush of the river bottoms until September 20. JUDD, 1917, p. 24; not common, said to breed near Devils Lake.

Mr. William Shunk has a spring record for Anselm of March 26, 1916. The species was present at Devils Lake until July 20, 1920, and arrived there May 9, 1921. I am certain a few breed there, but it is rather rare. I saw two birds at Grafton, July 24, 1921.

232. *Spizella pallida* (Swainson). Clay-colored Sparrow.

BAIRD, 1858, p. 475; records one from Fort Union collected July 18, 1856, by Dr. Hayden, and another at the same place collected in 1843 by J. J. Audubon. ALLEN, 1875, p. 58; common inhabitant of the sage brush everywhere. COUES, 1878,

p. 591; very abundant from Pembina to the Mouse River, and specimens were taken from June 3 to September 22, 1873. Coues, 1897, p. 21; on June 9, Harris and Bell shot some *Emberiza pallida* near the Little Missouri. Hoffman, 1882, p. 399; not common near the village, but more so at Fort Stevenson, seventeen miles below. Judd, 1917, p. 24; common summer resident, first seen early in May.

They were common at Devils Lake from May 7, 1921, throughout the summer. A set of four eggs in the Museum of Zoology Collection was taken June 20, 1900, at Sweetwater Lake by Charles L. Cass.

233. *Spizella pusilla arenacea* Chadbourne. Western Field Sparrow.

Allen, 1875, p. 57; frequent along Davis Creek in the Bad Lands of the Little Missouri, but not observed elsewhere. Schmidt, 1920, p. 321; a summer resident.

In Mr. William Shunk's list for Anselm, Ransom County, I found a spring date for this bird of April 4, 1916. I did not see one until June 16, 1921, when I secured specimens at Peaceful Valley Ranch near Medora. It is no doubt a rare or local bird in North Dakota.

234. *Junco aikeni* Ridgway. White-winged Junco.

Ridgway, 1901, p. 277; breeding in western North Dakota. Freeman, 1919, p. 14; one specimen observed. It is out of its range at Fargo. Schmidt, 1920, p. 331; a summer resident in western North Dakota.

235. *Junco hyemalis hyemalis* (Linnæus). Slate-colored Junco.

Coues, 1878, p. 593; appeared along the Mouse River about the middle of September in troops, and at once became abundant; specimens were collected there September 16 to October 5, 1873. Judd, 1917, p. 24; common migrant, have seen them as early as February 26. Freeman, 1919, p. 14; very common, spring and fall; March 15. Schmidt, 1920, p. 319; common migrant and occasional permanent resident.

This bird was seen only at Devils Lake, May 4, 1921.

236. *Junco hyemalis montanus* Ridgway. Montana Junco.

I know of but one record for the state, a mounted bird in the Williams Collection, taken at Grafton, April 9, 1921.

237. *Melospiza melodia juddi* Bishop. Dakota Song Sparrow.

Coues, 1878, p. 596; it appears to be rare in this part of the country, a specimen was taken at Turtle Mountains, August 2, 1873. Bishop, 1896, pp. 132-134; the type is an adult male, No. 1674, in the L. B. Bishop Collection, taken at Rock Lake, Towner County, May 11, 1895, by L. B. Bishop. Judd, 1917, p. 24; this subspecies described and named by Dr. L. B. Bishop was first found in the Turtle Mountains.

This sparrow was common at the Turtle Mountains in July and August, 1920; also on June 4 and 5, 1921. It was also abundant at Devils Lake when I arrived May 2, 1921, and was found in all the localities worked.

238. *Melospiza lincolni lincolni* (Audubon). Lincoln's Sparrow.

Baird, 1858, p. 482; one from the Upper Missouri taken in 1843 by J. J. Audubon. Coues, 1878, p. 595; occurs in large numbers during the latter part of September and first of October along the Mouse River; specimens were collected there September 16 to October 5, 1873. Judd, 1917, p. 24; tolerably common migrant, arrives from first to twenty-first of May. Schmidt, 1920, p. 321; a migrant.

It was seen only on May 5 and 6 near the Biological Station at Devils Lake, where one specimen was taken.

239. *Melospiza georgiana* (Latham). Swamp Sparrow.

COUES, 1878, p. 596; secured specimens from September 16 to October 5, 1873, on Mouse River. JUDD, 1917, p. 24; tolerably common migrant on the prairies, probably breeds in the Turtle Mountains, as a male in full song was taken about the middle of July.

There is a mounted specimen in the Agricultural College Museum taken at Grafton, September 30, 1912, by Henry Williams, and one taken September 14, 1914, at Grafton by Mr. Williams. In the Williams Collection at Grafton is a bird taken there April 25, 1913. A few individuals were seen in the marshes about Devils Lake and an immature male was taken August 19, 1920, at the Narrows.

240. *Passerella iliaca iliaca* (Merrem). Fox Sparrow.

JUDD, 1917, p. 24; rather rare migrant; earliest dates seen, April 20 and 29; seldom noted in the fall. SCHMIDT, 1920, p. 321; a migrant.

This species was not seen in life, but there is a mounted one in the Williams Collection taken at Grafton, June 28, 1904, by Mr. Williams.

The above species of sparrows are all very beneficial in their food habits, destroying immense quantities of weed seeds and many injurious insects.

241. *Pipilo erythropthalmus erythropthalmus* (Linnæus). Towhee.

COUES, 1878, p. 598; not uncommon about Pembina, where it was breeding in June. ABBOTT, 1880, p. 984; says he met the chewink but once, in July, 1879. JUDD, 1917, p. 24; rare, may be found breeding in the Turtle Mountains. FREEMAN, 1919, p. 14; probably a rare summer resident, May 16. SCHMIDT, 1920, p. 321; summer resident.

I saw this species in willow bushes near Bluebill Lake, Turtle Mountains, on August 1, 1920.

242. *Pipilo maculatus arcticus* (Swainson). Arctic Towhee.

BAIRD, 1858, p. 515; a male was taken at Fort Union in 1843 by J. J. Audubon. ALLEN, 1875, p. 59; a common inhabitant of the wooded bottomlands everywhere. COUES, 1878, p. 599; along the parallel of 49° this form becomes established at least as far east as the Mouse River, where a specimen was secured September 16, 1873. HOFFMAN, 1882, p. 399; frequently found in wooded bottomland near the agency. JUDD, 1917, p. 25; a rare straggler, one specimen taken. SCHMIDT, 1920, p. 321; summer resident west of central North Dakota.

This species was not seen until I reached Medora on June 14, 1921. It was common there and I am sure it nested, as it did also at Peaceful Valley Ranch, five miles north of Medora. It was also common about Williston, July 8 to 12, 1921.

243. *Cardinalis cardinalis cardinalis* (Linnæus). Cardinal.

MCCHESNEY, 1878, p. 78; only of casual occurrence in this region. On May 25, 1877, a pair was seen to the east of the Post, and a male was seen several times in this region. [This Post or Fort was in Roberts County near the northeast corner of South Dakota, and this species no doubt occurs there rarely along the Red River Valley.] SCHMIDT, 1920, p. 321; casual summer resident.

In a recent letter from Henry Williams, of Grafton, Walsh County, he records the taking of a female cardinal, November 4, 1921, near that city, the "first and only one I ever heard of in the state." I know of no other records.

244. *Zamelodia ludoviciana* (Linnæus). Rose-breasted Grosbeak.

Coues, 1878, p. 598; breeding in abundance at Pembina; specimens taken June 2 to 25, 1873. Judd, 1917, p. 25; tolerably common summer resident in the Turtle Mountains. Freeman, 1919, p. 14; very common summer resident where there are trees, May 12. Schmidt, 1920, p. 321; summer resident.

Mr. Russell Reid writes that he saw one in May, 1917, but has not seen them in the region of Bismarck since.

At Turtle Mountains I took an immature male, August 4, 1920. It was seen at Devils Lake on May 20, 1921, and remained a common summer resident.

245. *Zamelodia melanocephala* (Swainson). Black-headed Grosbeak.

Baird, 1858, p. 499; male from Fort Union, June 26, 1843, J. J. Audubon. Allen, 1875, p. 59; observed at frequent intervals along the wooded portions of the streams from the Missouri to the Yellowstone. Coues, 1897, p. 50; June 21 we shot a black-headed grosbeak at Fort Union. This is the only one noted by Audubon. Ridgway, 1901, p. 619; a specimen from Fort Union, North Dakota. Schmidt, 1920, p. 321; summer resident in western North Dakota.

Mr. Russell Reid writes me that he saw two birds and heard their singing in the Missouri River bottom near Bismarck on May 16, 1920, and observed another bird at the same place June 15, 1920.

This species seems to be a quite common summer resident in the western part of the state. It occupied the groves of cottonwoods along the Little Missouri near Medora, where I found a nest on June 23. On July 6 I found the species at Williston, on the Missouri River. Mrs. Grant Hayes saw a male at Grafton, January 3, 1922. This is the most eastern record I have for North Dakota, and this bird must be considered a straggler at a most unusual season of the year.

246. *Passerina cyanea* (Linnæus). Indigo Bunting.

Judd, 1917, p. 25; rare, seen only occasionally. Freeman, 1919, p. 14; uncommon summer resident. Schmidt, 1920, p. 321; rare summer resident.

I did not see this species in life, but there was a skin at the Agricultural College Museum, and Professor George Miller, the Curator, told me he had seen birds near Fargo. Mr. Russell Reid writes that he saw one near the Missouri River on June 30, 1921. It doubtless occurs only as a rare straggler in the eastern part of North Dakota.

247. *Passerina amoena* (Say). Lazuli Bunting.

Baird, 1858, p. 505; male from Fort Union, June 26, 1843, by J. J. Audubon. Allen, 1875, p. 59; quite abundant on the Missouri near Fort Rice, Morton County, and met with occasionally westward. Coues, 1897, pp. 31, 67, 79; Audubon, 1843, says on June 14 he saw lazuli finches at Fort Union, also on June 29 and July 7: p. 4; Audubon records seeing many lazuli finches along the Missouri River in Mor-

ton County, June 4, 1843. THWAITES, 1905, p. 386; at Fort Union, in June, 1833, Maximilian records seeing the beautiful bluefinch (lazuli bunting) first described by Say. SCHMIDT, 1920, p. 321; a summer resident of western North Dakota.

This species was found only near Medora, where on June 14 I saw a pair. At Olsen's Peaceful Valley Ranch there were a few others, June 17 to 20, 1921. It may be extending its range eastward, as it is a common summer resident in western Montana.

248. *Spiza americana* (Gmelin). Dickcissel.

RIDGWAY, 1901, p. 173; from the Upper Missouri River. (Maximilian, Jour. für Orn., VI, 1858, p. 341.) JUDD, 1917, p. 25; rare, small flocks seen in 1891, is only record I have, three full-plumaged males being taken at that time in the southeastern part of Towner County on Big Coulee. REID, 1921, No. 1, p. 8; not known here as a resident until 1921, when it appeared in considerable numbers near Bismarck, moving in and settling in territory new to the species.

Mr. Reid writes me that he saw several birds on Burnt Creek on June 26 and 27, 1921, the first year he had seen it.

This species was found to be a common summer resident in Ransom County, June 25 to 30, 1921. At Williston, July 7, I took one specimen, and at Bottineau, July 11 to 15, 1921, found it not rare, although Alfred Eastgate told me he had never before seen it in the county.

249. *Calamospiza melanocorys* Stejneger. Lark Bunting.

ALLEN, 1875, p. 58; observed it first about fifty miles west of Fort Rice, from there to Montana abundant in certain localities, preferring wet prairies near streams. COUES, 1878, p. 597; the apparent absence of this species from the Red River region, with its abundance on the Missouri, is one of the strong marks of difference in the fauna of the two watersheds. COUES, 1897, p. 105; July 21, Audubon says he saw many black-breasted lark buntings and found a nest with five eggs near Fort Union.

I did not note this species in eastern North Dakota, but at Mandan, June 24, saw the first ones. It was not noted about Medora, on the Little Missouri, but was a common summer resident about Williston, July 5 to 10, 1921. It was also common at White's Ranch, fifteen miles southwest of Bottineau, where I saw large flocks of adults and young on August 9, 1920. These were feeding about the ranch buildings like English sparrows.

250. *Piranga erythromelas* Vieillot. Scarlet Tanager.

JUDD, 1917, p. 25; rare, seen only in the Turtle Mountains. FREEMAN, 1919, p. 15; summer resident; May 16.

I did not see this species in life, but there is one specimen in the Williams Collection, taken at Grafton, July 30, 1904, and another, taken there May 24, 1914, by Henry Williams, is now in the Museum of Zoology Collection. A mounted specimen is in the Agricultural College Museum, taken at Grafton, May 26, 1914, by Mr. Williams. This species must be considered as a rare one in eastern North Dakota.

251. *Progne subis subis* (Linnæus). Purple Martin.

BAIRD, 1858, p. 315; a male was taken at Fort Union, July, 1856, by Dr. Hayden. COUES, 1878, p. 572; one specimen taken July 23, 1873, breeding on the Turtle Moun-

tains. RIDGWAY, 1904, p. 53; breeding at Pembina River and the Turtle Mountains. JUDD, 1917, p. 25; common summer resident in the Turtle Mountains, nesting in hollow trees.

This species was common at Devils Lake, May 2, 1921, and later hundreds nested in boxes about the Chautauqua grounds and in the hollows of trees about the lake.

I did not see martins at Medora or Williston, but saw a few at Bottineau, July 10, 1921. Mr. Williams has a specimen taken June 10, 1905, at Grafton, where he says they are common.

These birds are most beneficial in their food habits, living entirely on insect life.

252. *Petrochelidon lunifrons lunifrons* (Say). Cliff Swallow.

COUES, 1878, p. 571; the most abundant, generally distributed, and characteristic species of the family in the region. Specimens were taken at Pembina from June 13 to July 7, 1873. HOFFMAN, 1882, p. 398; not common, several nests found in the cliffs seven miles below the village, Fort Berthold, McLean County. COUES, 1897, p. 66; on June 29 Audubon found a flock of cliff swallows endeavoring to build nests beneath the ledges of a clay bank: p. 176; August 2, Bell found on a cliff numbers of cliff swallows' nests, with the old ones feeding the young. This is very uncommon at this late season. JUDD, 1917, p. 25; common summer resident; first seen May 24.

The species was first seen at Devils Lake, May 20, 1921, but a great migration occurred May 29, when hundreds of swallows, including many of this species were noted near the Station.

253. *Hirundo erythrogastra* Boddaert. Barn Swallow.

COUES, 1878, p. 570; commonly observed during July and August at various points, but only one specimen was taken in North Dakota, at the Mouse River, August 30, 1873. JUDD, 1917, p. 25; common summer resident, first seen second week in May and as late as October 20.

This species was first seen at Devils Lake, May 14, 1921, but on May 29, in a great migration of swallows, there were hundreds of this species, and it was later found to be common throughout the state.

254. *Iridoprocne bicolor* (Vieillot). Tree Swallow.

COUES, 1878, p. 571; only observed at Pembina, where it was breeding in small numbers about the Fort; a specimen was taken there June 19, 1873. JUDD, 1917, p. 25; common summer resident of wooded regions, arrives the first week in May.

This species was at Devils Lake on my arrival, May 2, and bred in some numbers about the lake. I also found it at the Turtle Mountains on June 5, 1921, but it is only locally common throughout the state.

255. *Riparia riparia* (Linnæus). Bank Swallow.

COUES, 1878, p. 572; generally distributed along the line west of Pembina and one was taken there June 13, 1873. HOFFMAN, 1882, p. 398; a few noticed north of the village at the sand-banks where the river formerly ran. JUDD, 1917, p. 25; common summer resident of prairies; not noted at the Turtle Mountains. FREEMAN, 1919, p. 15; very common summer resident.

The bank swallow seems to occur very generally throughout the state. A large colony nested at the Narrows, Devils Lake, in July, 1920, and a

small colony nested in a bank at the side of the road near the State Fish Hatchery in the Turtle Mountains, July, 1920. It was first seen in 1921 at Devils Lake, May 10.

All of the swallows are very beneficial in their food habits, as they live entirely on insects.

256. *Stelgidopteryx serripennis* (Audubon). Rough-winged Swallow.

ALLEN, 1875, p. 54; a colony found breeding in a sand bluff near our crossing of the Big Muddy, Morton County. A number of nests were examined July 1, 1873. All contained newly-hatched young. ABBOTT, 1880, p. 984; one at Pembina, July, 1879. RIDGWAY, 1904, p. 59; breeding in North Dakota.

I did not identify any birds of this species in the field, although no doubt some were seen among the many bank swallows. It is so nearly like the bank swallow that it is hard to distinguish in life, and may be more common than the records show. Specimens are in the Museum of the Agricultural College at Fargo, labelled Walhalla, North Dakota, July 6, 1912, W. B. Bell, and I saw one in the Williams Collection at Grafton, taken there July 1, 1914, by Mr. Williams.

257. *Bombycilla garrula* (Linnæus). Bohemian Waxwing.

THWAITES, 1906, Vol. III, p. 44; Maximilian says on December 13, 1833, several birds of the species *Bombycilla garrula* were brought to us at Fort Clarke. LARSON, 1913, p. 94; shot a solitary male on November 12, 1912, in McKenzie County, North Dakota. JUDD, 1917, p. 25; irregular winter visitant in small flocks. FREEMAN, 1919, p. 15; winter visitant, was very common two or three years ago; March 15.

The species was not seen in life, but I saw several mounted birds in the state. There were specimens in the collection of Mrs. Lucia Olsen, of Medora, who told me that they were very common winter visitants and fed on the berries of the red cedar. I also saw mounted birds in the Williams Collection at Grafton, labelled February 7, 1912, and was told that it was a common winter resident there. Mr. Russell Reid writes that it was not often seen, but was very common during the winter of 1919-1920 near Bismarck. According to Miss Zella Colvin, a large flock of Bohemian waxwings spent several weeks in Grand Forks during the month of January, 1922, feeding on Russian olives.

258. *Bombycilla cedrorum* Vieillot. CedarWaxwing.

COUES, 1878, p. 574; not seen at Pembina, but found at Mouse River, August 19 and Sept. 3, and at Long Coteau River, September 8, 1873. JUDD, 1917, p. 25; tolerably common summer resident of the Turtle Mountains.

I saw this species at Sully's Hill National Park on May 28, at Devils Lake July 21, at Williston July 6, and at Bottineau July 13, 1921. Mr. Russell Reid saw a large flock near Bismark, June 4, 1920.

259. *Lanius borealis* Vieillot. Northern Shrike.

LARSON, 1913, p. 94; seen only a few times in McKenzie County. JUDD, 1917, p. 25; tolerably common, early spring and late fall migrant. FREEMAN, 1919, p. 15; occasional winter visitant, seen in January and December.

I did not see this species in life, but found mounted specimens in Mrs. Olsen's Collection at Medora, and one in the Williams Collection taken at Grafton, November 1, 1912, by Henry Williams. Mr. Russell Reid writes that a pair nested on the grounds of the State Penitentiary at Bismarck, in 1915 and 1916.

260. *Lanius ludovicianus excubitorides* Swainson. White-rumped Shrike.

Coues, 1878, p. 576; the characteristic species of the whole region explored. Specimens taken June 1 to 14 at Pembina, July 30 and 31, 1873, at Turtle Mountains. Coues, 1897, p. 122; July 29 a loggerhead shrike was shot near Fort Union. Judd, 1917, p. 25; not at all common, have found them breeding on the shores of Lake Alice, Ramsey County.

The species was seen at Devils Lake on August 16, 1920, and on July 24, 1920, adults and nearly grown young were found at Stump Lake. In 1921 one was seen at Devils Lake on May 4, one near Cando on June 6, one at Medora on June 15, and another on June 23. Five were seen at Grafton on July 24, 1921.

261. *Lanius ludovicianus migrans* W. Palmer. Migrant Shrike.

H. C. Oberholser, Auk, Vol. XXXVII, No. 1, January, 1920, p. 136, records this specimen taken by H. V. Williams, of Grafton, North Dakota, on May 16, 1915.

In the Museum of Zoology there is a bird of this species, also taken at Grafton by Mr. Williams, on May 6, 1918.

262. *Vireosylva olivacea* (Linnæus). Red-eyed Vireo.

Allen, 1875, p. 54; common wherever there is timber. Coues, 1878, p. 574; abundant at Pembina, where it was breeding in June, and again near Fort Buford. Specimens were taken at Pembina, June 3 to 13. Judd, 1917, p. 25; common summer resident of the Turtle Mountains.

This species was at Devils Lake, May 23, 1921, and it was quite common there as a summer resident. It was also common in the Turtle Mountains in August, 1920, and doubtless occurs in all suitable habitats throughout the state.

263. *Vireosylva philadelphica* Cassin. Philadelphia Vireo.

Coues, 1878, p. 575; it undoubtedly breeds about Pembina, where specimens were taken June 3, 1873. Ridgway, 1904, p. 152; breeding at Pembina in June. Judd, 1917, p. 26; not uncommon as a summer resident of the Turtle Mountains.

I saw several in the Turtle Mountains on August 4, 1920. At Devils Lake it was not rare after May 23, 1921, and two were taken in the woods on the Rock Island Military Reserve.

264. *Vireosylva gilva gilva* (Vieillot). Warbling Vireo.

Allen, 1875, p. 54; common and generally distributed wherever there is timber. Coues, 1878, p. 575; observed in abundance at Pembina, where it was in full song and breeding in June. Specimens were taken there June 3 to 11, 1873. Ridgway, 1904, p. 154; breeding at Fort Rice and Pembina. Judd, 1917, p. 26; not common, found nesting in wooded regions.

I found it first on May 19, 1921, at Devils Lake, where it was a common summer resident. It was common in Medora in the grove of cottonwoods along the Little Missouri, June 16 to 20, and was also seen at Williston and Bottineau. It no doubt occurs throughout the state where suitable habitats are found.

265. *Lanivireo flavifrons* (Vieillot). Yellow-throated Vireo.

JUDD, 1917, p. 26; rare, taken in July in the Turtle Mountains, juveniles seen.

Mr. Williams' Collection contains a specimen taken at Grafton, July 1, 1914. The only one seen at Devils Lake was taken in the woods of the Rock Island Military Reserve on August 19, 1920. It was not noted again until July 25, 1921, when one was taken at Grafton. Doubtless it is rare throughout the state.

266. *Lanivireo solitarius solitarius* (Wilson). Blue-headed Vireo.

COUES, 1878, p. 576; one specimen of this rather rare species was secured June 4, 1873, at Pembina, which is probably about its northern limit. SCHMIDT, 1904; eastern North Dakota, rare.

The only one seen was a mounted specimen in the Williams Collection taken at Grafton, May 6, 1921, by Mr. Henry Williams.

267. *Mniotilta varia* (Linnæus). Black and White Warbler.

ALLEN, 1875, p. 52; a few were seen near Fort Rice, Morton County, June 10 to 20, 1873. COUES, 1878, p. 563; a single specimen was taken June 9, 1873, at Pembina, where it probably breeds. JUDD, 1917, p. 26; tolerably common summer resident of the Turtle Mountains, first noted May 11. FREEMAN, 1919, p. 15; transient visitant, fairly common in spring migration, May 7.

The species was present at Devils Lake from August 20 to 22, 1920. These birds were probably on their way south. Specimens were taken at Lake Upsilon, Turtle Mountains, on July 31, 1920. At Medora, on June 22, 1921, a male was taken in a red cedar thicket at the edge of the Little Missouri, where it no doubt nested. A pair of the birds was seen at Turtle Mountains, near Bottineau, July 13, 1921. Mr. William Shunk gave me a record for Ransom County of May 13, 1916.

268. *Vermivora celata celata* (Say). Orange-crowned Warbler.

COUES, 1878, p. 564; observed during the fall migration in September along the Mouse River, where ten specimens were taken from September 16 to 30, 1873. JUDD, 1917, p. 26; tolerably common migrant, taken as early as May 8.

I did not see this species in life, but saw a mounted bird in the Williams Collection taken at Grafton, May 10, 1914. Mr. Williams told me that they were not common there either in the spring or fall.

269. *Vermivora peregrina* (Wilson). Tennessee Warbler.

BAIRD, 1864, p. 179; a male from the Upper Missouri, Dakota, 1843, collected by J. G. Bell. COUES, 1878, p. 563; after the first of June the heavy timber of the river bottom at Pembina was filled with birds. Of thirteen specimens secured June 2 and 3, 1873, only three were males, as the migration was nearly over. JUDD, 1917, p. 26; tolerably common migrant, seen the first of June.

A few on their way south were seen at Devils Lake on August 17 and 21, 1920. Some were also noted there after May 23, 1921. Mr. Williams' Collection contains a mounted bird taken at Grafton, May 24, 1921.

270. *Dendroica tigrina* (Gmelin). Cape May Warbler.

JUDD, 1917, p. 26; rare migrant, taken as early as May 13. FREEMAN, 1919, p. 15; transient visitant, sometimes seen May 19.

I did not see this species in life, but there is a mounted specimen in the Williams Collection taken at Grafton, June 5, 1920, by Henry Williams.

271. *Dendroica aestiva aestiva* (Gmelin). Yellow Warbler.

ALLEN, 1875, p. 52; abundant along the Missouri and Heart rivers, 1873. COUES, 1878, p. 565; this abundant species was observed at various points along the whole line and in the Missouri region. Specimens were taken at Pembina, June 2 to 6, and at Mouse River, August 23, 1873. JUDD, 1917, p. 26; common summer resident, nesting in the prairie region and the Turtle Mountains.

This species was common at Devils Lake after May 16, 1921. I found it at all the localities worked, and believe it is a summer resident in suitable habitats throughout the whole state.

272. *Dendroica cærulescens cærulescens* (Gmelin). Black-throated Blue Warbler.

This species is not given in any of the published lists nor did I see it in life, but I found a mounted specimen in the museum of the Agricultural College at Fargo with no data.

273. *Dendroica coronata* (Linnæus). Myrtle Warbler.

COUES, 1878, p. 565; not seen until the middle of September, when it made its appearance in abundance along the Mouse River, where specimens were taken September 16-18, 1873. JUDD, 1917, p. 26; the most abundant warbler during migration, seen last week in April. FREEMAN, 1919, p. 15; very common, April 8. BAILEY, 1920, p. 105; yellow-rumped warblers were seen at Sweetwater Lake about the middle of September, 1917.

I found this species May 3, 1921, on my arrival at Devils Lake, and until May 19. It occurs as a migrant only, in North Dakota.

274. *Dendroica magnolia* (Wilson). Magnolia Warbler.

SCHMIDT, 1904; from the Red River Valley. JUDD, 1917, p. 26; rare, several taken second week in May, 1895. Migrant only. FREEMAN, 1919, p. 15; sometimes seen, May 9.

The species was seen but twice, at Devils Lake on May 20 and 24, 1921. Mr. Reid writes that he has only one record, Bismarck, May 12, 1920. There is a mounted specimen in the Williams Collection taken at Grafton, May 25, 1921.

275. *Dendroica pensylvanica* (Linnæus). Chestnut-sided Warbler.

COUES, 1878, p. 566; one specimen only of this distinctively eastern species was secured at Pembina, June 3, 1873, and no indication of its occurrence west of the longitude of the Red River was found. JUDD, 1917, p. 26; common migrant over prairies, nests in Turtle Mountains. FREEMAN, 1919, p. 15; probably summer resident, May 28.

I saw several birds of this species at Devils Lake and took one on May 21, 1921. None were observed in other localities.

276. *Dendroica castanea* (Wilson). Bay-breasted Warbler.

JUDD, 1917, p. 26; very rare, only one authentic record, a male, taken May 11, 1895, on an island in Rock Lake, Towner County. FREEMAN, 1919, p. 15; transient visitant, not often seen, May 27.

I did not see this species in life, but at Fargo in the Agricultural College Museum is a mounted bird taken there May 28, 1906, by W. B. Bell. It doubtless occurs in North Dakota as a very rare migrant.

277. *Dendroica striata* (J. R. Forster). Black-poll Warbler.

JUDD, 1917, p. 26; equals, if not surpasses, in numbers the yellow-rumped warbler in the wooded district. FREEMAN, 1919, p. 15; transient visitant, May 9.

The species was seen on May 21, 1921, at Devils Lake, where it was quite common until May 30. The Williams Collection contains a specimen taken at Grafton, May 25, 1921, by Henry Williams. It occurs only as a migrant in North Dakota.

278. *Dendroica fusca* (Müller). Blackburnian Warbler.

JUDD, 1917, p. 26; given as rare by Bryant at Freshwater Lake. FREEMAN, 1919, p. 15; transient visitant, frequently seen; May 18.

I did not see this species in life, but saw a mounted specimen in the Williams Collection taken at Grafton, June 1, 1918, by Mr. Williams.

279. *Dendroica virens* (Gmelin). Black-throated Green Warbler.

FREEMAN, 1919, p. 15; transient visitant, few data; May 16.

The only record known to me for the state.

280. *Dendroica vigorsi* (Audubon). Pine Warbler.

SCHMIDT, 1904; migrant in the Red River Valley. SCHMIDT, 1920, p. 327; migrant.

The only references I find for the state.

281. *Dendroica palmarum palmarum* (Gmelin). Palm Warbler.

SCHMIDT, 1904; the Red River Valley. JUDD, 1917, p. 26; rare migrant, noted from first of May. FREEMAN, 1919, p. 15; sometimes seen along the river; May 13.

The species was seen from May 10 to 18, 1921, at Devils Lake, where it was found on the high, stony beaches feeding among the silver-leaf bushes. A specimen taken at Grafton, May 6, 1921, by Henry Williams, is in the Williams Collection.

282. *Seiurus aurocapillus* (Linnæus). Oven-bird.

ALLEN, 1875, p. 52; abundant in the timbered bottom lands about Forts Rice and Abraham Lincoln, Morton County, and observed on Heart River, 1873, but not seen elsewhere on the trip. JUDD, 1917, p. 26; rare summer resident of the Turtle Mountains. FREEMAN, 1919, p. 15; probably summer resident, May 12.

The species was seen only at Cando, Towner County, June 2, 1921, in a small grove near the home of Mr. E. T. Judd. It must occur only locally as a rare summer resident in North Dakota.

283. *Seiurus noveboracensis notabilis* Ridgway. Grinnell's Water-Thrush.

Judd, 1917, p. 26; common at Rock Lake between May 9 and June 20, also in the Turtle Mountains during July, where a nest with three eggs was found July 15, 1916. Freeman, 1919, p. 15; occasional transient visitant, May 19.

Mr. Reid reports that he saw large numbers of these birds on Burnt Creek, Burleigh County, May 15, 1917. The species was at Devils Lake from May 10 to 17, 1921. It was also rather common and bred at Lake Upsilon, Turtle Mountains, July 30 to August 7, 1920, as a juvenile bird was taken there on July 30, 1920.

284. *Oporornis agilis* (Wilson). Connecticut Warbler.

Abbott, 1880, p. 984; one taken July 11, 1879, near Pembina.

I find but one published record for North Dakota. Mr. Alfred Eastgate, who lived for several years at Stump Lake, is my authority for two specimens taken there May 3, 1903.

285. *Oporornis philadelphia* (Wilson). Mourning Warbler.

Coues, 1878, p .568; breeding abundantly at Pembina, where specimens were taken June 2 to 30, 1873. Judd, 1917, p. 27; tolerably common migrant on the prairies and one of the most common summer residents of the Turtle Mountains. A brood of young just from the nest was seen in July. Freeman, 1919, p. 15; transient visitant, May 26.

I saw this species first at Devils Lake on May 23, 1921, in a small willow thicket near the edge of Creel Bay, and on June 3 collected two in a small poplar grove near Cando, Towner County. At Grafton I saw a mounted specimen in the Williams Collection taken there May 24, 1915.

286. *Geothlypis trichas trichas* (Linnæus). Maryland Yellow-throat.

Ridgway, 1902, p. 665; records this species from Fort Rice and Pembina, North Dakota. He also examined one specimen from North Dakota.

287. *Geothlypus trichas occidentalis* Brewster. Western Yellow-throat.

Coues, 1878, p. 567; observed at Pembina and Turtle Mountains and specimens collected at Pembina, June 5, and Turtle Mountains, July 28, 1873. Ridgway, 1902, p. 669; from the Missouri River, North Dakota. Judd, 1917, p. 27; common summer resident of prairies and the Turtle Mountains; earliest date, May 3.

I first noted this species May 20, 1921, at Devils Lake. Later it was seen at all the localities worked, and is no doubt locally common throughout the state. Mr. Henry Williams took a male at Grafton, May 24, 1921.

288. *Icteria virens longicauda* Lawrence. Long-tailed Chat.

Allen, 1875, p. 45; at Fort Rice, Morton County, this species was very abundant the third week in June, 1873. It was common in the woodlands along the Missouri, also seen on Heart River and the Little Missouri. Coues, 1878, p. 569; up the Missouri to beyond the mouth of the Yellowstone. Thwaites, 1906, p. 31; near Fort Union, July 8, 1833, Maximilian records the yellow-breasted chat singing among the thickets, especially in the rose bushes. Schmidt, 1904; lists it as occurring in the western part of North Dakota, but gives no data.

I first found this species on June 16, 1921, at the Peaceful Valley Ranch in willow thickets along the Little Missouri River, but later, June 23, I

found it at Medora in the thick brush of a cottonwood grove. I did not see it at Williston, as the thickets and low places were flooded and could not be worked.

289. *Wilsonia pusilla pusilla* (Wilson). Wilson's Warbler.

JUDD, 1917, p. 27; rather rare migrant, usually seen latter part of May. FREEMAN, 1919, p. 16; a transient visitant.

I did not see this species in the field, but there was a mounted one in the Williams Collection taken at Grafton, May 21, 1921. Mr. Reid writes that three were seen on May 25, 1921, near Bismarck.

290. *Wilsonia canadensis* (Linnæus). Canada Warbler.

SCHMIDT, 1904; Red River Valley.

The species was not seen in the field, but I examined a mounted one in the Williams Collection taken at Grafton, May 23, 1921, by Henry Williams.

291. *Setophaga ruticilla* (Linnæus). Redstart.

ALLEN, 1875, p. 53; quite common along the Missouri at Fort Rice, Morton County, in June, 1873, where it was apparently breeding. COUES, 1878, p. 570; very abundant at Pembina, where it breeds. Specimens were taken there June 2 and 3, 1873. SCHMIDT, 1904; nesting throughout the state. JUDD, 1917, p. 27; common migrant of prairie and summer resident of the Turtle Mountains, Graham's Island, and other wooded tracts. FREEMAN, 1919, p. 16; common summer resident, May 14.

I did not see this species until May 21, 1921, at Devils Lake, where it was not common as a resident or even as a migrant.

All of the warblers are very beneficial in their food habits and destroy many injurious insects.

292. *Anthus rubescens* (Tunstall). Pipit.

ALLEN, 1875, p. 50; quite common about September near Heart River, Morton County. COUES, 1878, p. 557; a bird of passage in spring and autumn. In September they appeared in numbers along the Mouse River; one was taken there September 2, 1873. HOFFMAN, 1882, p. 398; only a few noticed after the 10th of September. SCHMIDT, 1904; rare migrant in central North Dakota. JUDD, 1917, p. 27; regular migrant in spring, more common in September.

I did not see this species in life, but Mr. Reid writes me that these birds were quite common on Horseshoe Lake, in northeast Burleigh County, on September 25, 1921.

293. *Anthus spraguei* (Audubon). Sprague's Pipit.

BAIRD, 1858, p. 234; records the type (No. 1854), a female taken, 1843, at Fort Union, North Dakota, by J. J. Audubon. ALLEN, 1875, p. 50; first observed along the Heart River fifty miles west of Fort Rice, Morton County, where it was more or less common. COUES, 1878, p. 558; breeding in great numbers in the prairie region twenty miles west of Pembina Mountains. The first one was collected on July 14, and it was seen daily to October 1, 1873, at Mouse River. HOFFMAN, 1882, p. 398; rather abundant the early part of September in grassy areas and stubble fields; less numerous after the 15th and 20th. COUES, 1807, p. 41; June 10, 1843, Audubon says, Harris and Bell have brought to my delight and utter astonishment a new bird, a lark, small and beautiful. In a foot-note Dr. Coues says, this is the first intimation we have of the discovery of the Missouri titlark which Audubon

dedicated to Mr. Sprague: p. 55; on June 24 Audubon records shooting four larks, and he describes at length their flight and beautiful song: p. 88; July 14, he shot seven more near Fort Union, Williams County. Ridgway, 1904, p. 21; breeding in the Red River Valley, North Dakota. Judd, 1917, p. 27; fairly common summer resident.

The only ones noted by the writer were heard singing high in the air above low alkali flats or pastures near the edge of West Bay, Stump Lake, July 25, 1920. In July last, Mr. Elmer T. Judd, of Cando, Towner County, wrote me that the air was full of their beautiful song. Senator Crawford, of Sentinel Butte, has written me that Sprague's pipit is one of the rare prairie birds and that he has never been able to find a nest of this bird, although he has found the young.

294. *Oreoscoptes montanus* (J. K. Townsend). Sage Thrasher.

Ridgway, 1907, p. 260; from western North Dakota.

I find no other record.

295. *Mimus polyglottos polyglottos* (Linnæus). Mockingbird.

The only record known to me for the state is of a bird taken on the campus of the University of North Dakota, November 23, 1916, by Professor C. C. Schmidt. This bird was noted in the vicinity for several days after all other migrants had gone south. It was no doubt an accidental straggler.

296. *Dumetella carolinensis* (Linnæus). Catbird.

Coues, 1878, p. 551; one of the common breeding species of the Red River region and west to the Turtle Mountains. Specimens were taken at Pembina, June 13 to 30, and Turtle Mountains, July 23, 1873. Judd, 1917, p. 27; tolerably common summer resident of this territory, seen third week in May.

I saw it at Devils Lake in May, 1921, and found it one of the most common land birds of that region as well as over the rest of the state in suitable habitats.

297. *Toxostoma rufum* (Linnæus). Brown Thrasher.

Coues, 1878, p. 551; observed at Pembina. One was taken at Pembina, June 21, 1873, and one at Fort Buford, Williams County, in July, 1874. Schmidt, 1904; all parts of the state. Judd, 1917, p. 27; rather rare, probably nests in the Turtle Mountains. Freeman, 1919, p. 16; very common summer resident, May 10.

I saw this species at Devils Lake after May 10, 1921. At Medora I also found a few in June, and it was quite common at Bottineau in July. The food habits are mostly beneficial.

298. *Salpinctes obsoletus obsoletus* (Say). Rock Wren.

Baird, 1858, p. 358; a male taken at Fort Union, July 8, 1843, by J. J. Audubon. Allen, 1875, p. 50; first met with about some rocky buttes near the Big Muddy, Morton County; common in the Little Missouri Bad Lands in the summer of 1873. Coues, 1897, p. 97; July 18, Audubon shot five rock wrens near Fort Union: p. 122; July 29, Harris and Bell shot two rock wrens; August 8, saw a family of rock wrens and shot four near the same place. Schmidt, 1904; migrant, central North Dakota. Judd, 1917, p. 27; but one known record; took a specimen in spring of 1896, in a woodpile at Cando, Towner County.

299. *Troglodytes aëdon parkmani* Audubon. Western House Wren.

COUES, 1878, p. 554; observed as far west as the confines of the Missouri Coteau. In June it was breeding very abundantly at Pembina, on the Red River, where specimens were taken June 2 to June 26. Others were taken at Mouse River, September 3, and Long Coteau River, September 11, 1873. THWAITES, 1906, p. 213; on November 3, 1833, Maximilian records seeing a wren in driftwood along the river below Fort Union. He says it was doubtless *Troglodytes hyemalis*, but at this late date it may have been the winter wren. JUDD, 1917, p. 27; very common summer resident of the Turtle Mountains; it arrives about May 15.

I first saw the species at Devils Lake, May 19, 1921, and later it was at all of the localities worked. Coues' notes are given under the eastern form and Schmidt also lists *aëdon aëdon*, but we refer all North Dakota specimens to the western house wren. A set of seven eggs in the collection of the Museum of Zoology was taken June 15, 1896, at Sweetwater Lake, Ramsey County, by E. S. Bryant. This is a very beneficial species generally distributed in North Dakota.

300. *Nannus hiemalis hiemalis* (Vieillot). Winter Wren.

JUDD, 1917, p. 27; rare, now and then one seen. SCHMIDT, 1904; eastern North Dakota.

I did not see this species in life, but there was a mounted one in the Williams Collection at Grafton, taken there April 15, 1921, by Henry Williams, who told me it was the only one seen there in his many years of collecting. It is no doubt a rare migrant in North Dakota.

301. *Cistothorus stellaris* (Naumann). Short-billed Marsh Wren.

COUES, 1878, p. 555; rather plentiful along the Red River; a male was taken at Pembina, June 4, and at Mouse River, August 9, 1873. COUES, 1897, p. 90; July 15, Audubon says he heard the notes of the short-billed marsh wren near Fort Union: p. 107; July 21, found the short-billed marsh wren very abundant. SCHMIDT, 1904; central and eastern North Dakota. BAILEY, 1916, p. 20; saw and heard many in the lake region of North Dakota. JUDD, 1917, p. 28; locally common; nests in high, thick grass near sloughs; arrives May 6 to 28. FREEMAN, 1919, p. 16; summer resident, not common.

This species was not seen at Devils Lake, but on July 29, a colony was found near Anselm, Ransom County, where they were nesting in the tall grass of a dry slough. Specimens were seen in the Agricultural College Museum from Hankinson, taken July 23, 1919, by W. B. Bell, and from Fargo, September 28, 1912, W. B. Bell. A nest in the Museum of Zoology was taken at Sweetwater Lake by Charles L. Cass.

302. *Telmatotydes palustris iliacus* Ridgway. Prairie Marsh Wren.

RIDGWAY, 1904, p. 494; from Chief Mountain Lake, North Dakota. SCHMIDT, 1904; central and eastern North Dakota. BAILEY, 1916, p. 20; common in the lake region. JUDD, 1917, p. 28; locally common; nests in high rushes.

They were found on July 29, near Anselm, Ransom County, nesting in tall rushes growing in the water of an extensive pond or slough. The wrens are all very beneficial in their food habits and destroy many injurious insects.

303. *Certhia familiaris americana* Bonaparte. Brown Creeper.

Schmidt, 1904; nesting in western North Dakota. Judd, 1917, p. 28; rare, an irregular migrant, no known instance of its breeding. Stevens, 1918, No. 1, p. 47; two seen on Christmas Day at Fargo, North Dakota.

I did not see this species in the field, but there was a mounted one in the Agricultural College Museum at Fargo, labelled November 16, 1912. It must be recorded as a rare migrant in North Dakota.

304. *Sitta carolinensis carolinensis* Latham. White-breasted Nuthatch.

Schmidt, 1904; eastern North Dakota. Judd, 1917, p. 28; tolerably common migrant, probably breeding in the Turtle Mountains. Stevens, 1918, p. 47; saw two on Christmas Day near Fargo, North Dakota. Freeman, 1919, p. 16; permanent resident.

Mr. Reid observed it in the Missouri River bottom on April 12-13, 1921, and on October 22, 1921.

This species was found at Devils Lake, May 7, 1921, but was not very common. On June 5 I saw one at Lake Upsilon, Turtle Mountains.

305. *Sitta canadensis* Linnæus. Red-breasted Nuthatch.

Schmidt, 1904; all over North Dakota as a migrant. Judd, 1917, p. 28; not uncommon during September and October, but not noted in the spring. Freeman, 1919, p. 16; common in spring and fall, May 7. Bailey, 1919, p. 227; September 2, near Sweetwater Lake.

I did not see this species in life, but saw a mounted bird in the Agricultural College at Fargo, taken at Grafton, September 21, 1913, by Henry Williams. The nuthatches are very beneficial, as they destroy both larvae and eggs of many injurious species of insects.

306. *Penthestes atricapillus septentrionalis* (Harris). Long-tailed Chickadee.

Coues, 1878, p. 554; an abundant resident of the region of the Upper Missouri in all suitable situations. Schmidt, 1904; breeding in central North Dakota. Thwaites, 1906, p. 208; October 30, 1833, near Fort Union, Maximilian records seeing the titmouse among the willow bushes. Larson, 1913, p. 94; common on the river bottom, McKenzie County, in the timber. Not often found any other place. Judd, 1917, p. 28; rather common resident in the Turtle Mountains, also has records from there. Freeman, 1919, p. 16; very common, permanent resident.

In 1920 the species was seen in the Turtle Mountains, August 2, and at Devils Lake, August 24. They were at the lake on May 9, 1921, and at Medora from July 14 to 21. On June 28, 1921, I saw a family of five in the thick woods along the Sheyenne River near Anselm, Ransom County.

The species is beneficial in its food habits, living almost entirely on the eggs and larvae of injurious insects.

307. *Penthestes hudsonicus hudsonicus* (J. R. Forster). Hudsonian Chickadee.

The only record known to me is of a bird taken November 20, 1919, at the State Fish Hatchery on Lake Upsilon, by Mr. Alfred Eastgate. It may occur as a winter resident or only as a straggler in the Turtle Mountains.

308. *Regulus satrapa satrapa* Lichtenstein. Golden-crowned Kinglet.

SCHMIDT, 1904; central North Dakota. JUDD, 1917, p. 28; only one record of this species near Cando. FREEMAN, 1919, p. 16; very common most years; March 27.

I did not see this species in life, but there was a mounted specimen in the Williams Collection at Grafton, taken there April 23, 1914, by Henry Williams. The scarcity of records proves its rarity in the state.

309. *Regulus calendula calendula* (Linnæus). Ruby-crowned Kinglet.

COUES, 1878, p. 553; observed in September on Mouse River in the dense undergrowth of the river bottom. SCHMIDT, 1904; central North Dakota. JUDD, 1917, p. 28; tolerably common spring migrant. FREEMAN, 1919, p. 16; very common transient visitant, April 11.

I did not see this species in July or August of 1920, but on May 7, 1921, I saw several at Devils Lake, where they were rather common until May 11. William Shunk, of Anselm, noted one at Grand Forks, April 12, 1916.

310. *Hylocichla mustelina* (Gmelin). Wood Thrush.

Mr. Russell Reid is authority for one seen May 1, 1917, near Bismarck, but it must be considered only as a rare straggler in the state.

311. *Hylocichla fuscescens salicicola* Ridgway. Willow Thrush.

COUES, 1878, p. 550; observed in the vicinity of Pembina, where it bred in June in abundance. HOFFMAN, 1882, p. 398; one shot by an Indian boy near Fort Berthold in early September. A few others were seen in thickets. SCHMIDT, 1904; central and eastern North Dakota. He also lists the Wilson thrush, which no doubt has been confused with the willow. RIDWAY, 1907, p. 68; breeding at Pembina. JUDD, 1917, p. 28; abundant summer resident of the Turtle Mountains.

This species was quite common at Devils Lake after May 10, 1921, throughout the summer, and was seen in the Turtle Mountains near Bottineau, July 13, 1921.

312. *Hylocichla aliciæ aliciæ* (Baird). Gray-cheeked Thrush.

SCHMIDT, 1904; eastern North Dakota. JUDD, 1917, p. 28; common migrant, first seen the second week of May. FREEMAN, 1919, p. 16; common transient visitant, May 24.

It was common at Devils Lake for a few days after May 10, 1921.

313. *Hylocichla ustulata swainsoni* (Tschudi). Olive-backed Thrush.

COUES, 1878, p. 550; observed only in September along the Mouse River, where one was taken September 16, 1873. SCHMIDT, 1904; eastern and western North Dakota. JUDD, 1917, p. 28; a rare spring migrant, not noted in the fall. FREEMAN, 1919, p. 16; common transient visitant, April 16.

This species was found at Devils Lake, May 16, 1921, but by about May 20 all had gone north. A mounted male in the Williams Collection was taken at Grafton, June 30, 1910.

314. *Hylocichla guttata pallasi* (Cabanis). Hermit Thrush.

SCHMIDT, 1904; from central and eastern North Dakota. FREEMAN, 1919, p. 16; common transient visitant, April 8.

This species was not seen in the field, but the Williams Collection contains one taken at Grafton, April 24, 1919, and Mr. William Shunk noted one near Anselm in 1915.

315. *Hylocichla guttata sequoiensis* (Belding). Sierra Hermit Thrush.

Mr. Russell Reid sent a bird collected at Bismarck, April 26, 1921, to Mr. H. C. Oberholser, who identified it as this species.

316. *Planesticus migratorius migratorius* (Linnæus). Robin.

COUES, 1878, p. 549; found in abundance at Pembina, where it was breeding in the wooded river bottom. Specimens were collected there, June 12 to 24, and at Mouse River, September 16, 1873. SCHMIDT, 1904; all over the state. LARSON, 1913, p. 94; two seen January 26, 1913, McKenzie County. JUDD, 1917, p. 28; in 1910 one of the most common nesting birds about Cando. FREEMAN, 1919, p. 16; very common summer resident, March 18.

It is a common bird throughout the state.

317. *Sialia sialis sialis* (Linnæus). Bluebird.

COUES, 1878, p. 553; the eastern bluebird was not observed at Pembina. SCHMIDT, 1904; all over the state. JUDD, 1917, p. 28; rare summer visitor, but is becoming more common as the country is settled. FREEMAN, 1919, p. 16; fairly common summer resident, March 22.

This species was at Devils Lake May 2, 1921, and it was seen at Medora June 23, also at Williston, on the Missouri River, July 7, 1921. Mrs. Dana Wright, of Jamestown, writes that she saw a bluebird May 10, and that a pair usually nest in a neighbor's yard.

318. *Sialia currucoides* (Bechstein). Mountain Bluebird.

BAIRD, 1858, p. 225; a male was taken at Fort Union, July 1, 1843, by J. J. Audubon. COUES, 1897, p. 50; Audubon says, June 21 Sprague shot a superb specimen of the arctic bluebird: p. 79; on July 7, saw others at Fort Union. SCHMIDT, 1904; western North Dakota. JUDD, 1917, p. 28; rare early spring visitor. Irregular in its appearance here.

I saw three western bluebirds, June 17, in the petrified forest, twelve miles north of Medora, and there was also one at the Peaceful Valley Ranch, on the Little Missouri River, on June 17, 1921. There is a mounted bird in the Williams Collection taken at Grafton, April 10, 1921.

INTRODUCED SPECIES

319. *Passer domesticus* (Linnæus). English Sparrow.

This species has occupied nearly all of the state, and is all too common about dwellings and towns.

320. *Colinus virginianus virginianus* (Linnæus). Bob-white.

HOFFMAN, 1882, p. 403; two individuals were seen near Fort Berthold in September. These no doubt came from Fort Sully, where some were liberated about three or four years before. SCHMIDT, 1904; rare, introduced. JUDD, 1917, p. 15; admitted on hearsay; heard of a flock of a dozen near Grand Harbor, 1894-1895, presumably shipped in and turned loose there. FREEMAN, 1919, p. 12; rare, no data.

321. *Phasianus.* English Pheasant.

North Dakota has three state game farms where this species is raised, and from them it has been introduced into various localities throughout the state, and in some places seems to be increasing in numbers. It is a question, however, if the money and effort needed to successfully introduce this species could not be better employed to protect and propagate the many fine native game birds which are better adapted to the natural conditions of the state.

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PLATE I

Figure 1. Shore of Devils Lake.

Figure 2. Mauvaise Coulee.

Figure 3. Fish Hatchery and Lake Upsilon, Turtle Mountains.

Figure 1

Figure 2

Figure 3

PLATE II

Figure 1. Swampy meadow and prairie near Devils Lake.

Figure 2. Missouri River near Williston.

Figure 3. Little Missouri River and grove of cottonwood near Medora.

Figure 1

Figure 2

Figure 3

PLATE III

Figure 1. Nest of ferrugineous roughleg hawk, near top of butte, north of Esmond. Photograph by P. B. Peabody.

Figure 2. Saskatchewan horned lark on nest, Bismarck, June 6, 1921. Photograph by Russell Reid.

Figure 1

Figure 2

PLATE IV

Figure 1. Long eared owl on nest. Hay Creek near Bismarck, May 22, 1921. Photograph by Russell Reid.

Figure 2. Nest of chestnut-collared longspur near Esmond. Photograph by P. B. Peabody.

Figure 3. Nest of yellow rail near Esmond, June 7, 1912. Photograph by P. B. Peabody.

Figure 1

Figure 2

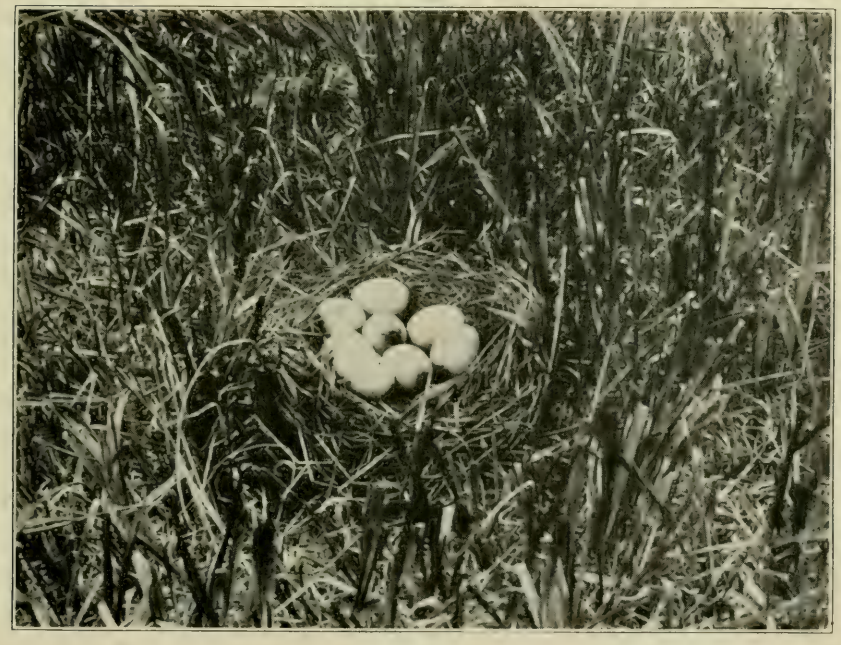

Figure 3

PLATE V

Figure 1. Nests of double crested cormorants. Bird Island, Devils Lake, 1920. Photograph by Crystal Thompson.

Figure 2. Lark bunting on nest. Bismarck, July 6, 1921. Photograph by Russell Reid.

Figure 1

Figure 2

PLATE VI

Figure 1. Nest and eggs of LeConte's sparrow. North Dakota. Photograph by P. B. Peabody.

Figure 2. Western grasshopper sparrow. Photograph by P. B. Peabody.

Figure 3. Nest of Baird's sparrow near Esmond, June 5, 1919. Photograph by P. B. Peabody.

Figure 4. Nest of ring-neck duck. Devils Lake Region, July 20, 1919. Photograph by P. B. Peabody.

Figure 1

Figure 2

Figure 3

Figure 4

UNIVERSITY OF MICHIGAN
MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 11

Notes on the Genus Erythemis With a Description of a New Species (Odonata)

BY

E. B. WILLIAMSON

The Phylogeny and the Distribution of the Genus Erythemis (Odonata)

BY

CLARENCE HAMILTON KENNEDY

ANN ARBOR, MICHIGAN
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The publications of the Museum of Zoology, University of Michigan, consist of two series—the Occasional Papers and the Miscellaneous Publications. Both series were founded by Dr. Bryant Walker, Mr. Bradshaw H. Swales and Dr. W. W. Newcomb.

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

NOTES ON THE GENUS ERYTHEMIS WITH A DESCRIPTION OF A NEW SPECIES (ODONATA)

By E. B. Williamson

This paper discusses in a general way the distribution of the species of the genus and some possible factors involved, recording specimens taken in the Canal Zone, Panama, Colombia, and Venezuela;[1] the genus is defined, following earlier authors; a key to the species, based on some characters heretofore used and on some new characters, and therefore supplementary to keys by Calvert and Ris, is given; and a new species, the first to be recognized as such in this genus for many years, is described. The paper deals only with imagos.

A General Consideration of the Distribution of the Species of Erythemis

A reference to the literature, summarized by Ris in Coll. Zool. de Selys, will reveal at once the wide distribution of the species of this genus. For example, seven of the eight known species occur in the West Indies, yet none is peculiar there, and of the seven species, five have each a range at least from Mexico to Paraguay. These dragonflies have been generally successful in passing over or around whatever obstacles the varied topography of tropical America could offer to their dispersal.

Dragonflies as larvae and adults are active and more or less independent of any one particular source of food. The larvae are aquatic and are hence dependent on some water supply. The adults are on the wing when they seize their food, and hence can sustain themselves only under certain weather conditions which are equally important for mating and ovipositing. In conformity with the complexities of multiform bodies of water under diverse climatic conditions, we find equally complex adjustments of dragonflies to meet varying conditions. Regions with pronounced seasons, involving changes in precipitation or temperature or both, and dry or frigid regions, have relatively fewer species of dragonflies than tropical regions with a more uniform climate and an abundant water supply throughout the year. In eastern North America the broad belt of dragonfly fauna bounded on the south by the northernmost extension of such genera as Dythemis, Orthemis, Brachymesia, and Neoneura, for example, and on the north by Cordulia, Agrion, and the bulk of Somatochlora and Aeshna, for example, is probably confined to its area and protected from encroachments from the south and north largely by the temperature factor in the climate.

Directly associated with the adjustments of dragonflies to seasonal changes is their dependence on the orderly sequence of these seasons. Hence, in any

[1] See first paragraph, *Misc. Publ., Mus. of Zoology, University of Michigan*, No. 9.

region of marked seasonal changes there are more or less frequent changes in the dragonfly fauna of various habitats due to unusual or abnormal seasons. It is obvious that the premature drying up of a pond might result in the death of the larvae of several species. An unusually high water stage of a river might submerge all the resting places for emerging larvae at the time when they are due to emerge, or might coat larvae with a deposit of stiff clay, resulting in the wholesale destruction of many species. Late frosts in early summer or a premature freeze in the fall might cause the death of imagoes and thus at least temporarily eliminate certain species from certain habitats. Unusual seasons may also operate to the advantage of certain extralimital species. For example, an early and continuously warm spring may permit the extension northward of a southern species, and it is probably this factor, associated possibly also with favorable air currents, that sometimes carries the southern *Pantala hymenaea* as far north as Ontario.

In the low-lying American tropics temperature ceases to be an important factor in itself in determining dragonfly distribution. Drought takes its place. Drought makes itself felt even in the well-watered and forested equatorial belt, though, due to permanent rivers and lakes, its effect is not universal over a region as low temperature is. It is obvious, with low temperature absent as a limiting factor in the seasonal distribution of dragonflies, at least as imagoes, that more numerous adjustments in other factors are possible in the life histories of these insects. For example, in the north the rigors of winter can be bridged by a dragonfly only in the egg or larval stage, but in the tropics it is not impossible that the period of drought might be passed as an egg, a larva, or an imago. The existence in the tropics of both temporary and permanent bodies of water have resulted in many diverse adjustments in the life histories of dragonflies, both as larvae and imagoes, to these periods of drought. For example, warmth and abundant food obviously might permit the shortening of larval life, while other factors might permit the indefinite extension of imaginal life. When, as is usually the case, temporary and permanent bodies of water occur in close proximity in a region, the result is a rich and varied dragonfly fauna.

It is interesting to note that in the tropics many of the most successful and specialized dragonflies are those which depend on, or are able to endure, a temporary water supply (wet weather ponds or streams) for their larval life, and that in the north our highly specialized species are pond and lake (not stream) dwellers.

Too little is known of the detailed life histories of neotropical dragonflies to allow us to cite particular examples of the various adjustments indicated as possible in the preceding paragraphs. This is true of the species of Erythemis, and yet enough is known to permit of a few positive statements and some warranted conclusions. The larvae of the species of Erythemis, so far as known, are pond or lake dwellers, always so, possibly, in the case of some species, and frequently or usually in the case of all. The adults have a long seasonal range, occurring on the wing apparently throughout the year, and are apparently as numerous, if not more numerous, during the dry season. Since the larvae of some, if not all, may live in temporary as well

as permanent ponds, and since during the dry season the imagoes are numerous, it is very probable that the larval life is brief, and it is not improbable that the dry season is bridged by imagoes rather than by drought resistant eggs or larvae. We know that old and worn females, which might well have lived throughout the dry period, are still able to oviposit; and we know that when dry depressions become pools with the coming of the rainy season ovipositing individuals of species of several genera, including Erythemis, immediately put in an appearance.

It is not improbable that species of dragonflies whose larval life is spent in temporary pools and whose imaginal life is continued during the dry season are less bound to the vicinity of the location of these pools than are species whose larval life is spent in permanent bodies of water and which would therefore develop a stronger fixed habitat tendency through numberless generations of larvae and adults attached to a particular habitat. A longer larval life might also strengthen this tendency. It may be safely concluded that dragonflies emerging from temporary pools after a short larval life and with a long imaginal life, under favorable conditions for extended flight (the dry season in the tropics) before them, will be wide wanderers, and, other conditions permitting, species of wide distribution.

So far as species of Erythemis are concerned, temperature is not a limiting factor over the large area included in tropical America. Swamps, ponds, pools, and lakes of varied characters, permanent and temporary, are abundant and widely scattered over this region, forming, with the exception of the southwest coast of South America, a practically continuous habitat. Species of Erythemis as imagoes are active and conspicuous, apparently living happy, care-free lives so far as predaceous enemies are concerned. They are voracious feeders on a varied diet of other insects, including species which are not dependent on bodies of water during their own lives, such as Lepidoptera. Hence, they can find a living anywhere and are not held to the immediate vicinity of their birthplace, as are many species whose imaginal food consists largely, if not entirely, of aquatic insects, and whose adaptability to a varied diet may be limited. Because of their larval life in both temporary and permanent pools, individuals are numerous as compared with other simliar species whose larval life is confined to permanent pools, and, at the time of ovipositing, when active competition takes place, the males of one species protecting their own females against attacks and at the same time hustling away from the water the females of other species, Erythemis, because of its numbers and activity, is at no disadvantage. The eggs of Erythemis are dashed in the water and oviposition is as safe against parasitism of the eggs as it is in the other large number of species of similar habit. There is no reason to think the larvae of Erythemis are exposed to any particular danger. Their use of temporary pools would relieve them of competition or attack of many forms of aquatic life, while their successful use of permanent pools indicates they can meet the conditions there.

From the above considerations, we can understand the wide distribution of species of Erythemis which have been able to cross the great river valleys of South America, which valleys, marking frequently the broad areas which

separated earlier distinct continental land masses, have proved efficient barriers for many species. These valleys may be mechanical barriers or they may merely mark separate regions in each of which, through long adjustment, conditions have resulted which prevent the occupation of one region by many species from another region. Barriers, in any case, exist only in connection with specialized habits of dragonflies. For a high stream species a long mountain range might offer a continuous highway, which would be an insurmountable barrier for a low pond species. A long, broad valley, forming a great stretch of suitable habitat for the pond species, might prove an impassable barrier for the high stream species. In either case, if the river valleys are barriers, Erythemis has occupied and passed them, and if the higher regions themselves are exclusive to species from other regions, Erythemis, because of certain characteristics discussed and doubtless others, has successfully forced its way, at least to some extent, into the new environment. As a result, the present distribution of species offers, I believe, an unsolvable problem for the student who would determine the place of origin and trace the routes of distribution of the species of this genus. For example, Fundación, Colombia, lies in the relatively isolated Santa Marta region, and at this one station five species of Erythemis occur, and these five occur in Central America, the West Indies, and to the south to Paraguay. At Tucacas, Venezuela, four species have been recorded, and I have no doubt more careful collecting there would add at least two species. At El Banco, in the lower Magdalena, six species have been taken.

When we speak of the distribution of dragonflies or anything else, we imply, of course, the known distribution. The relation of the known distribution to the real distribution depends on the thoroughness with which collections are made. And this thoroughness depends on the number and distribution of collectors and the degree of success of each collector in obtaining everything in his specialty in each locality he works. And the collector's degree of success, other things being equal, depends on the relative conspicuousness of the things he collects. The imagoes of species of Erythemis are conspicuous insects, and the records of their capture are correspondingly numerous. Though collectors and localities visited in the past have been few in numbers with what we may expect in the future, probably our knowledge of the distribution of species of Erythemis corresponds at least in a broad way with the real distribution of these insects. Compare the status of our knowldge in this genus with that of some of the gomphines, for example. To cite one case, we know that the genus Erpetogomphus occurs in South America because of the capture, which might be described as accidental, of two specimens in Colombia and three in Venezuela—a total of five specimens for the continent.

Definition of the Genus

The following definition of Erythemis is compiled almost entirely from other authors. *Head* moderate or small; eyes joined for only a short distance; frons moderately prominent, rounded, without anterior ridge; vertex moderately high, apex slightly emarginate. *Hind lobe of prothorax* erect,

as wide or wider than the other lobes, slightly or scarcely indentate in the middle posteriorly, the posterior and lateral margins with long hairs. *Thorax* moderately robust. *Abdomen* variable, stout to slender, inflated or not at the base, never distinctly dilated apically, segments 2 and 3, but not 4, each with a distinct median transverse carina. *Legs* stout, third femur of the male with an antero-ventral row of 15-30 small, regular teeth, and a postero-ventral row of similar but less numerous teeth, which rows reach from the base to about two-thirds the length of the femur, the apical third with three stout equal spines in the antero-ventral row and two of the same size in the postero-ventral row; second femur similarly formed with the basal rows of teeth shorter, reaching only about half the length of the femur, the number of teeth reduced and the apical spines variable in number, three or four in each row; third femur of female similar to second femur of male, ten or fewer teeth in the basal rows which reach from the base to, or not as far as, the middle of the femur, each row followed by 3 or 4 spines of unequal size; second femur of female similar to the third, but the apical spines reduced in number; spines on third tibia in both sexes stout, about 8 in each row, slightly weaker and less numerous on the other tibiae; claws of tarsi toothed before the tip. *Accessory genitalia* of male small, hamule two-branched. *Abdominal appendages* of male simple, superiors slightly constricted postbasally, then enlarging to beyond mid-length and then more rapidly reduced to a superior acute apex, a ventral row of small black teeth; inferior appendage triangular, shorter than the superiors, apex blunt or truncate, not deeply emarginate. *Lateral margins of segments* 8 of female not expanded. *Vulvar lamina* a more or less erect plate or trough. *Wings* long, moderately broad, the triangles at about the same level in front and hind wings, triangle of front wing narrow, the anterior side much shorter than the proximal, once crossed, triangle of hind wing and supertriangle of both wings free, subtriangle of front wing three-celled, sectors of arculus joined in a long stalk, arculus between first and second antenodal, base of triangle of hind wing at the arculus, 11-15 antenodals in the front wing, the last not continuous, one bridge cross-vein, one cubito-anal cross-vein in each wing, normally two cross-veins under the stigma, space between the last postnodal and stigma normal, not distinctly longer than adjacent spaces between postnodals, basal and apical parts of stigma about the same color, not distinctly bicolored, Cu_1 and Cu_2 in hind wing separate at origin, Rs and Rspl separated by one row of cells, M_2 with a single slight curve, not distinctly waved, Cu_1 in front wing strongly curved, the area between it and M_4 near their terminations in the wing margin wide, in front wing two (rarely three for one row's length) rows of cells between A and the hind margin of wing at level of arculus, anal field of hind wing broad, usually three (sometimes four and always two in *credula*) rows of cells between A_3 (A_2 of Laidlaw) and hind margin at level of base of triangle, two postanal cells in front wing, A_2 (Cuspl of Laidlaw) in hind wing slightly angled, the angle at about the level of distal angle of triangle, less rather than more distal, in hind wing three to five cells between Cu_1 and Cu_2 from triangle to distal angle of anal loop, one cell only between posterior angle of triangle and A_2 (Cuspl of

Laidlaw) in hind wing, triangle of front wing followed by three cells (rarely two in *credula*) followed by three rows (usually but not always by two rows in part of the field in *credula*), increasing to more at or distal to the level of the distal cell between M_4 and Mspl, hind wing with two postriangular rows of cells increasing to three at or distal to the level of forking of M_{1-2} and M_3.

The striking difference in the form of the abdomen of *haematogastra* or *plebeja*, for example, on one hand and *mithroides* or *peruviana* on the other, more than any other one character, led authors, prior to Calvert in 1906, to distribute the species of Erythemis in three genera. But between the extremes named above the remaining five species may be arranged from more slender to less slender in approximately the following order: *carmelita, credula, simplicicollis, attala,* and *collocata.*

Another striking difference within the genus is the color of adults, especially of males, some having more or less of the body, but especially the abdomen, brilliant red, while in others no red or reddish appears in the coloration. This latter group includes some which are largely greenish or yellowish as tenerals and become dark bluish pruinose with age, while other darker species become deep black with age. This not-red group includes both slender and stout species, and also among the reds we have the extreme forms of abdomen. In the same way, among tenerals there are species with a distinctly patterned thorax and species which lack a definite pattern, the thorax being practically concolorous. And in each group are slender and stout species, and red and not-red species.

Thus, the species within the genus are well marked and easily recognized, but efforts to define more than one generic group seem futile.

In addition to the characters mentioned above, the accessory genitalia of the male and the vulvar lamina of the female are specifically distinct. In the case of the males, however, those individuals in which the penis is extruded usually, but not invariably, have the internal branch of the hamule bent outward and backward, so that the normal relation between the internal and external branches is lost.

KEY TO THE SPECIES OF ERYTHEMIS

1. Lateral and ventral carinas on abdominal segment 3 at the apex, measured along the apical carina, separated by .8 mm. or less; the distance between the same carinas, opposite the meeting point of the lateral and median transverse carinas, equal to more than one and one-half times the distance between them at apex; lateral and ventral carinas on segment 4 separated by a distance less than one-sixth the length of the lateral carina of segment 4 (possibly not always true of *credula*). Ventral teeth on the superior appendages of the male extending posteriorly beyond the level of the apex of the inferior appendage ..... 2.

1'. Lateral and ventral carinas on abdominal segment 3 at the apex, measured along the apical carina, separated by 1 mm. or more; the distance between the same carinas, opposite the meeting point of the lateral and median transverse carinas, equal to one and one-half times or less the distance between them at apex; lateral and ventral carinas on segment 4 separated by a distance greater than one-sixth the length of the lateral carina of segment 4 (possibly not always true of *simplicicollis*). Legs of adults largely black or dark brown..... 5.

2 (1). Abdomen less than 30 mm. long, shorter than the hind wings. Dorsum of thorax distinctly patterned, paler above, bordered on either side with antehumeral black or the thorax black. Yellowish or greenish to black insects. Male with the external branch of the hamule triangular in shape, the postero-ventral edge longer than the distance between the apex of the internal branch and the antero-ventral angle of the external branch. Female lamina short (not seen by me) ..... *credula.*

2'. Abdomen 30 mm. long or longer. Male with the external branch of the hamule rounded, the postero-ventral edge equal to or shorter than the distance between the apex of the internal branch and the antero-ventral angle of the external branch ..... 3.

3 (2'). Tibiae, and to a lesser extent the femora, largely dark brown or black. Abdomen and hind wings about equal in length. Male with the external branch of the hamule rounded, the postero-ventral edge equal to or slightly shorter than the distance between the apex of the internal branch and the antero-ventral angle of the external branch. Female lamina trough-shaped, projecting ventrad, the apex not distinctly bent and not directed caudad ..... 4.

3'. Legs largely pale. Hind wings longer than the abdomen. Thorax not distinctly patterned paler and darker. Yellowish or greenish to red insects. Male with the external branch of the hamule rounded, the postero-ventral edge about equal to, or slightly more than, half the distance between the apex of the internal branch and the antero-ventral angle of the external branch. Female lamina distinctly bent so the apical lobe is directed caudad, and, in lateral view, there is a deep posterior emargination between the basal lobes and the apex; from apex to base of basal lobe of lamina about .9 mm.; apex of sternum of segment 9 with a patch of sparse bristles ..... *carmelita* n. sp.

4 (3). Dorsum of abdominal segments 5-10 predominantly dark or black; dorsum of thorax distinctly patterned, paler above, bordered on either side with a black antehumeral band, or the thorax black. Yellowish or greenish to black insects. Male with external branch of the hamule directed ventrad, in posterior view erect. Female lamina from base of basal lobe to apex 1.5 mm.; apex of sternum of segment 9 with a patch of sparse bristles (80%) or with a single transverse row (20%) ..... *plebeja.*

4'. Dorsum of abdominal segments 5-10 predominantly pale; dorsum of thorax not distinctly patterned paler and darker. Green or yellowish-green to red insects. Male with the external branch of the hamule directed more caudad than ventrad, not erect in posterior view. Female lamina from base of basal lobe to apex .75 mm.; apex of sternum of segment 9 with a single row of bristles (80%) or with a patch of sparse bristles (20%) ..... *haematogastra.*

5 (1'). Labrum, face and frons pale colored, green and yellow. Wing bases unmarked or, at the most, hind wings basally tinged with yellow. Thorax not definitely patterned; green or yellowish green to dark pruinose. Male with ventral teeth on the superior appendages extending posteriorly beyond the level of the apex of the inferior appendages; external branch of the hamules directed more caudad than ventrad, genital lobes reaching ventrad far beyond the level of the hamules. Female lamina from base to apex about 1.25 mm., in antero-ventral view rounded triangular in shape, in lateral view the posterior basal lobe scarcely evident; apex of sternum of segment 9 with a single, or at most a double row, of bristles (true also of *peruviana*) ..... 6.

5'. Labrum, face and frons not as above. Base of hind wings distinctly dark or at least (some females) tinged with yellow. Thorax yellowish or greenish yellow to red or black. Male with ventral teeth on the superior appendages extending posteriorly to about the same level as the apex of the inferior appen-

dage or not that far; external branch of the hamules directed ventro-caudad, extending ventrad about as far as or farther than the genital lobes. Female lamina in antero-ventral view, if triangular, swollen at base on either side, in lateral view the posterior basal lobe distinct; apex of sternum of segment 9 with a patch of bristles (except *peruviana*)..... 7.

6 (5). Lateral and ventral carinas on segment 4 separated by a distance about one-fifth the length of the lateral carina.....*simplicicollis.*

6'. Lateral and ventral carinas on segment 4 separated by a distance about one-third the length of the lateral carina.....*collocata.*

7 (5'). Dark basal area on hind wings reduced, not reaching the cubito-anal crossvein. Thorax distinctly patterned with a median rectangular pale area above, bordered on either side with black, to entirely black in old males which have abdominal segments 4-10 bright red. Lateral and ventral carinas on segment 4 separated by a distance about equal to one-third the length of the lateral carina. Male with the external branch of the hamules and the genital lobes reaching ventrad to about the same level, or the genital lobes very slightly longer; apical ventral teeth on the superior appendages about the level of the distal end of the inferior appendage. Female lamina in antero-ventral view semicircular, length from base of basal lobe to apex about .65 mm.; apex of sternum of segment 9 with a single row of bristles.....*peruviana.*

7'. Dark basal area on hind wings reaching beyond the cubito-anal crossvein. Thorax not patterned with a median rectangular pale area bordered on either side with black. Lateral and ventral carinas on segment 4 separated by a distance less than one-third the length of the lateral carina. Male with the external branch of the hamules reaching ventrad distinctly beyond the level of the genital lobes. Female lamina in antero-ventral view not semicircular, length from base of basal lobe to apex about 1.2 mm.; apex of sternum of 9 with a patch of bristles..... 8.

8(7'). Thorax largely dark or black, intricately patterned with paler, to completely black in old males. Abdomen black in old males, in others largely dark with conspicuous large basal or subbasal pale (yellow) areas, only narrowly separated by black in the median line, on segments 4 and 7. Dark colored to black insects. Lateral and ventral carinas on segment 4 separated by a distance equal to or less than one-fourth the length of the lateral carina. Male with the apex of the inferior appendage reaching beyond the level of the ventral teeth on the superior appendage. Female lamina in antero-ventral view nearly as long as wide, rounded triangular, slightly swollen at base on either side.....*attala.*

8'. Thorax pale yellowish or greenish to dark red, without dark markings. Abdomen largely pale, yellowish to bright red. Pale colored to red insects. Lateral and ventral carinas on segment 4 separated by a distance equal to between one-third and one-fourth the length of the lateral carina. Male with the ventral teeth on the superior appendages extending posteriorly to about the same level as the apex of the inferior appendage. Female lamina in antero-ventral view trilobed, the width about one-half greater than the length.....*mithroides.*

Erythemis carmelita, new species

Plate I, figs. 1-6

Abdomen, male 31-31.5, female 32-33; hind wing, male 34.5-35, female 35; stigma, male 3-3.2, female 3.4-3.6.

Male.—Rear of head brownish red or yellow, labium yellow, darkening to red anteriorly and mesially, labrum orange, clypeus, frons, vesicle and occiput red, the last and the anteclypeus duller.

Prothorax and thorax yellowish or greenish red, possibly bright red in life in old males, unmarked. Legs yellowish (ochraceous-tawny of Ridgway), the antero-dorsal surface of the first femur and tibia black; second femur with the same surface largely black, and a narrow line of black on the same surface of the second tibia; third femur with the same surface with an ill-defined, restricted, subapical black area equal in length to about one-fourth the length of the femur; a narrow interrupted line on the same face of the third tibia; all tarsi darker, obscure to black; all spines and teeth on the legs, black, of usual form. Front wings at base with a trace of yellowish red. Hind wings with a yellowish red basal spot which anteriorly reaches the first antenodal and posteriorly is slightly more extensive, a few of the included cells sometimes with a dark reddish brown spot at the center. Stigma brown, narrowly shaded darker along the anterior edge.

Abdomen, including accessory genitalia and apical appendages red, the genitalia and appendages paler, yellowish; all unmarked, except for restricted black edgings on some carinas, especially on the apical carina; segments 4-9 in dorsal view shading apically into darker red. Abdomen inflated at base, 3 at base 5 high, 4, 1.6 high; 4-6 in dorsal view measure about as follows: 4, 1.6 wide at mid-length, and 4.8 long; 5, 1.9 wide and 4.6 long; 6, 2.1 wide and 4.4 long; 7-9 are about as wide as 6, 9 slightly narrower, and 10 is about 1.8 wide; in length, 7-10 are, respectively, 3.6, 2.4, 2, and 1. In profile at mid-length, 4 is about 1.1 high; from this point the abdomen gradually thickens posteriorly to the apex of 8, which is about 1.8 high. Lateral and ventral carinas on segment 3 separated at the apex by about .8, at the level of the point where the lateral meets the median transverse by about 1.6; on 4 the lateral carina is about 4.7 long and the lateral and ventral carinas are separated by a distance of .5 to .7.

Female.—Rear of head pale dull yellowish, a reddish brown spot on either side above and below against the eye, head pale as in the male but dull pale greenish brown without trace of red, the labium and anteclypeus yellowish.

Thorax dull green (about Saccardo's olive of Ridgway in dried specimens), unmarked. Legs slightly duller than in the male, similarly marked. Wings hyaline without basal markings or with yellowish red at the base to a varying extent, from a mere trace to, at the other extreme, in the front wings about one-third the distance to the first antenodal and in the hind wings slightly beyond the first antenodal. Stigma brown, narrowly shaded darker along the anterior edge.

Abdomen dull green, about the same color as the thorax, with 4-10 apically dark; 1-3 with the carinas slightly darker or more yellowish than the body of the segments; 4-7 shading to black apically, the apical third to half of each segment dark; 8-10 largely or entirely dark to black; the appendages and the lamina supra-analis lying between them yellowish to black, the latter about .67 long and 1 wide at base, triangular, the apex truncated, about .3 wide, and each posterior angle a rounded knob or tubercle so the apex is broadly emarginate or divided. Abdomen inflated at base, 3 at base about 4.5 high, 4 about 2.1 high; 4-6 in dorsal view measure about as follows: 4,

1.7 wide at mid-length and 5.6 long; 5, 1.9-2 wide and 5-5.2 long; 6, 2.1-2.4 wide and 4.8-5 long; 7-9 are about as wide as 6, 9 slightly narrower, and 10 is about 1.6 wide; in length, 7-10 are, respectively, 3.8-4, 2-2.4, 1.6-1.9, and .8-.9. In profile, at mid-length 4 is about 1.8 high; from this point posteriorly the abdomen is about the same height to near the apex of 8, the apex of which segment is 2.6-2.8 high. Lateral and ventral carinas on segment 3 separated at the apex by about .8, at the level of the point where the lateral meets the median transverse by about 1.2-1.4; on 4 the lateral carina is about 5.2 long and the lateral and ventral carinas are separated by a distance of .6-.7.

Venation, male and female.—Antenodals, front wing 13-15 (15 in 14%, 13 in 21%, 14 in 64%), hind wing 9-11 (11 in 14%, 9 in 28%, 10 in 57%); postnodals, front wing 9-10 (10 in 35%, 9 in 64%), hind wing 10-11 (11 in 14%, 10 in 85%). In front wing usually two rows of cells between A and the hind margin at level of arculus, but in four male wings the distal row of cells (the row against the subtriangle and the postanal cells) consists of three. In the hind wing three or four rows of cells between A_3 (A_2 of Laidlaw) and the hind margin. In hind wing 4+ cells between Cu_1 and Cu_2 from triangle to distal angle of anal loop, except in one female wing, where there are 5 cells. In anal loop 9-11 cells between A_2 and A_3 (Cuspl and A_2 of Laidlaw) (11 in one female wing, 9 in three male wings, 10 in all others).

Described from four males and one female, El Banco, Colombia, January 23-25, 1917; one male, Rio Neuvo, between Magangué and El Banco, Colombia, January 22, 1917 (both localities in the lower Magdalena River Valley); one female, Tucacas, Venezuela, March 23, 1920 (all above material in coll. E. B. W.); and one female, Boa Vista do Jaquiri, near the mouth of the Rio Teffé, Brazil, September 5, 1920, W. T. M. Forbes, coll. Cornell University. Type, the male from Rio Neuvo, allotype female, El Banco, January 25, 1917. Named in honor of Mrs. M. A. Carriker, Jr. (née Carmelita Flye), whose courage and industry as a member of Mr. Carriker's expeditions in the American tropics merit recognition.

Specimens of this species have been sent to Drs. Calvert and Ris, and both pronounce it new. Unfortunately, our notes give no particular data as to habits of the species. The male at Rio Neuvo was taken in a bit of dry (at that season) pastured woods. At El Banco we collected a variety of habitats, but most of our material was taken in dry (at that season) woods and brush adjoining the river, and nearly dried up adjacent pools. At Tucacas on March 23 we collected at a large lagoon, possibly an old river bed, lying on the north side of the railroad and between four and five kilometers out of town. This lagoon has large areas of deep open water bordered at places by more extensive low areas filled with rosette-leaved plants, sedges, grasses, and several species of bushes. At places large areas of this sedgy, brushy marsh were floating on the deeper waters of the lagoon, and about such places, crocodiles were very numerous. The more solid ground about the lagoon is covered with pastured grass, dense thickets of small spiny trees or shrubs, and forests. Strong flying libellulines are numerous about the margins of the deeper water in the lagoon.

Carmelita is separated from all other species by its paler legs. It is separated from the less densely veined, very distinct and smaller *credula* by venational characters indicated in the definition of the genus. With the exception of *simplicicollis* and *collocata,* the species of Erythemis are very distinct and it is difficult to distinguish relationships within the genus. However, *carmelita* is probably more closely related to *haematogastra* than to any other species. Characters given in the key readily separate them.

A LIST OF THE SPECIES RECORDED IN THIS PAPER, WITH PLACES AND DATES OF CAPTURE[1]

The species are arranged alphabetically and numbered consecutively. Following each locality under each species are numbers in parentheses indicating the other species taken at the same place. For example, *E. plebeja* Burmeister. *Venezuela:* Encontrados, (1, 5, 6), indicates that *attala, mithroides,* and *peruviana,* in addition to *plebeja,* were taken at Encontrados.

1. *Erythemis attala* Selys
2. " *carmelita* Williamson
3. " *credula* Hagen
4. " *haematogastra* Burmeister
5. *Erythemis mithroides* Brauer
6. " *peruviana* Rambur
7. " *plebeja* Burmeister

1. *Erythemis attala* Selys. *Colombia*: Fundación, (4, 5, 6, 7), January 13, 1917; El Banco, (2, 4, 5, 6, 7), January 23 and 25, 1917. *Venezuela:* Palma Sola, (5, 6, 7), March 8, 1920; Encontrados, (5, 6, 7), April 25, 1920.

Attala is a widely distributed and therefore apparently a common species, but I have never found it in great numbers at any particular habitat. In fact, the total Colombia-Venezuela catch numbers only four males and three females. However, Bates, as recorded by Ris, notes: "Dry woods at Santarem, very common, much more abundant than *plebeja.*" As opposed to my general statement that tropical species of the genus are probably on the wing throughout the year is the fact that Hine and I failed to get *attala* at Amatillan, Gualan, and Los Amates, in Guatemala, in January, 1905, while I took it at the three localities in June, 1909. But available records show *attala* on the wing somewhere every month in the year, except September, November, and December, and there is no doubt it flies these months, too; and our failure to find it in January in Guatemala was probably due to its relative scarcity and to its having deserted the permanent bodies of water (where we did most of our collecting) to range about in the dry brush.

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[1] For notes on localities, see: A Collecting Trip to Colombia, South America, by E. B. Williamson, *Miscellaneous Publications, Univ. of Mich., Mus. of Zool.,* No. 3, February 22, 1918; and Notes on the Habitats of Some Tropical Species of Hetaerina, by E. B. Williamson, *Occ. Papers, Univ. of Mich., Mus. of Zool.,* No. 130.

Localities not discussed in these papers or in the description of *E. carmelita* are briefly described at the end of this paper. The student may be interested to note that at the following locations, described in *Occasional Papers,* No. 130, no species of Erythemis have been recorded: Aroa, Boqueron, Cincinnati, Cristalina, La Fria, Maraquita, Nirgua, San Esteban, and Tachira.

The elevation of the three Guatemalan localities mentioned are, moreover, above the apparently optimum habitats of species of Erythemis (due probably rather to the relative absence of such pools as occur at lower levels than to elevation itself), and it may be noted that on February 5, 1905, we found the species at sea level at San José, Guatemala.

Attala is an active species in a genus of generally active species, and at times individuals are seen whose incessant activity and wariness effectually prevent their capture. It is a matter of common observation among strong-flying species of dragonflies that in an assemblage of only a few individuals of a species such individuals are much more wary of the collector than individuals in a numerous assemblage when their attention is largely given to each other, and the collector finds their capture less difficult. This will often explain the extreme wariness of *attala* which, as stated above, has not been noted as very numerous about any particular habitat in Colombia or Venezuela.

2. *Erythemis carmelita* Williamson. *Colombia*: Rio Neuvo, (5, 6), January 22, 1917; El Banco, (1, 4, 5, 6, 7), January 23-25, 1917. *Venezuela:* Tucacas, (5, 6, 7), March 23, 1920. See description of this species in this paper for further notes.

3. *Erythemis credula* Hagen. *Panama:* Gamboa, Canal Zone, (6), August 5, 1920, J. H. Williamson.

Credula is apparently, next to *carmelita,* the rarest species of the genus and J. H. W.'s record for Panama is the first for Central America. I have seen the species alive at only one locality, Pitch Lake, Trinidad, where the males were flying about the small pools of water in the pitch.

4. *Erythemis haematogastra* Burmeister. *Colombia:* Rio Frio, (5, 6, 7), January 8, 1917; Sevilla, December 15, 1916; Fundación, (1, 5, 6, 7), January 12 and 13, 1917; El Banco, (1, 2, 5, 6, 7), January 24 and 25, 1917; Puerto Berrio, (5, 6), January 8 and February 21, 1917. *Venezuela:* El Guayabo, (5, 6, 7), April 20, 1920.

Bates, as recorded by Ris, notes: "Rather common species at Santarem; it frequents only the shade of the woods and settles frequently on dried twigs. Banks of brooks, Pará, not uncommon." So far as I have observed, this species is rare, being found usually only as a solitary individual sunning itself on some twig or broad leaf near or far from water. In fact, the total Colombian-Venezuelan catch numbers only fifteen specimens, nine males and six females; the number of specimens taken at each locality varies from one to three, except at El Banco, where five specimens were collected.

5. *Erythemis mithroides* Brauer. *Colombia:* Santa Marta, (7), December 19, 1916; Rio Frio, (4, 6, 7), January 7, 1917; Fundación, (1, 4, 6, 7), January 13 and 14, 1917; Bolivar, (6, 7), December 20, 23, and 26, 1916; Rio Neuvo, (2, 6), January 22, 1917; El Banco, (1, 2, 4, 6, 7), January 23-25, 1917; Puerto Berrio, (4-6), January 30, 1917. *Venezuela*: Tucacas,

(2, 6, 7), March 23 and 24, 1920; Palma Sola, (1, 6, 7), March 4, 6, and 10, 1920; Encontrados, (1, 6, 7), April 23 and 25, 1920; El Guayabo, (4, 6, 7), April 20 and 22, 1920.

In life *mithroides* is a rich-colored and active species, usually with lower flight than the slender species *haematogastra* and *plebeja*, which are possibly more wary and active than *mithroides*. About the ponds where *mithroides* often occurs in considerable numbers it is often seen resting on the leaves of coarse grasses and sedges, its color and activity making it conspicuous. We have found it in numbers on several occasions: the pond on the upper side of the railroad out from Santa Marta and just beyond the bridge over the Manzanares; the large swamp south of Mamatoca near Bolivar; and the little ponds along the railroad and beyond the Caña Fraile out from El Guayabo.

One of two males taken at Rio Neuvo has the triangle of both front wings free. One of the large males taken in Guatemala and described by Dr. Ris (Coll. Selys, p. 1173) was referred to Dr. Kennedy, who kindly examined the penis of the specimen and found it agreeing with penes of smaller specimens of the species.

6. *Erythemis peruviana* Rambur. *Panama:* Gamboa, Canal Zone, (3), August 5, 1920, J. H. Williamson. *Colombia:* Rio Frio, (4, 5, 7), January 4 and 6-8, 1917; Fundación, (1, 4, 5, 7), January 10 and 12, 1917; Bolivar, (5, 7), December 19, 23, and 26, 1916; Rio Neuvo, (2, 5), January 22, 1917; Magangué, January 21, 1917; El Banco, (1, 2, 4, 5, 7), January 24, 1917; Las Delicias, January 28, 1917; Puerto Berrio, (4, 5), January 31 and February 8, 1917. *Venezuela:* Tucacas, (2, 5, 7), March 23 and 24, 1920; Palma Sola, (1, 5, 7), March 4, 6, 8, and 9, 1920; Bejuma, (7), February 16, 1920; Encontrados, (1, 5, 7), April 23, 25, and 26, 1920; El Guayabo, (4, 5, 7), April 20, 1920.

Bates, as recorded by Ris, states: "Banks of brooks near Pará, Obydos very plentiful." In fact, this species may occur about some favored habitat in possibly larger numbers than we have ever seen any other species of the suborder Anisoptera. Under such circumstances, usually about a pond or muddy, sluggish, and sun-exposed creek or ditch, most, if not all, of the individuals will be teneral or lacking the colors of the fully adult. However, a few mature ones in full flight, by their restless activity and general impertinence toward other species, may make collecting of other Anisoptera at the same habitat difficult or well-nigh impossible. And when at some swamp or pond the collector finds *peruviana* represented by only one or two adult males, he will usually find the capture of these a difficult or even impossible feat if he depends solely on his insect net.

As in other species observed, the females of *peruviana* are more voracious feeders than the males. A female taken at Encontrados, Venezuela, was feeding on a butterfly, *Thymelicus athenion* Huebner, as determined by Mr. William Schaus. In fact, Lepidoptera seem to be a favorite food for species of Erythemis, and I have records of *simplicicollis* in Indiana feeding on *Thecla liparops* Bd. and Lec., and *Haploa confusa* Lyman, both determinations by Dr. Dyar.

In marked contrast to the dull, common-looking tenerals and females, the fully adult males of *peruviana* are among the most brilliant and handsome of dragonflies. In flight they are swift and agile, and suggest *simplicicollis*, but I have never observed them indulging in the complicated evolutions of the latter species.

7. *Erythemis plebeja* Burmeister. *Colombia:* Puerto Colombia, December 10 and 11, 1916; Santa Marta, (5), December 13, 16, and 18, 1916, and January 3, 1917; Don Jaca, December 17, 1916; Rio Frio, (4, 5, 6), January 4-8, 1917; Fundación, (1, 4, 5, 6), January 13, 1917; Bolivar, (5, 6), December 20, 21, 23, and 26, 1916, and January 2, 1917; Zambrano, January 20, 1917; El Banco, (1, 2, 4, 5, 6), January 23, 1917; Gamarra, January 27, 1917. *Venezuela*: Tucacas, (2, 5, 6), March 23, 25, 1920; Palma Sola, (1, 5, 6), March 8 and 10, 1920; Bejuma, (6), February 13, 18, and 24, 1920; Encontrados, (1, 5, 6), April 25, 1920; El Guayabo, (4, 5, 6), April 20, 1920.

A male of this species, collected in Jamaica and received from Carpenter, is labelled *haematogastra,* but I do not think this mistake is likely to be frequent as, if any confusion occurs as regards *plebeja,* it is likely to be with *attala;* and as Calvert has pointed out, the adult male of *haematogastra* superficially resembles the adult male, not of another Erythemis, but a species of another genus, *Rhodopygia hollandi,* just as another Erythemis, *peruviana,* superficially resembles *Planiplax sanguiniventris* rather than some other species of Erythemis.

Bates, as recorded by Ris, states of *plebeja:* "Banks of the river Tapajos near Santarem, settling on bushes in the woods." It is an agile species and is found widely scattered in practically all the environments of any locality where it occurs.

CONCLUSIONS

Finally, I should like to call attention to the present status of Erythemis and a very different genus of American dragonflies, Hetaerina, and to certain facts in their life histories, leaving to other students any conclusions as to the significance of these facts in explaining present conditions. There are nine known species of Erythemis as against about fifty species of Hetaerina. And yet, in any locality (an area three to ten miles in diameter) the largest known list of Hetaerinas is four species, or eight per cent of the total, while in Erythemis the largest local list is six species, or sixty-six and two-thirds per cent of the total. Moreover, in any locality the species of Erythemis there tend to more fully occupy the various environments of the locality than do Hetaerinas, or one environment in the locality may harbor all the Erythemis found there, while these conditions are usually reversed in Hetaerinas, each species often showing a marked preference for a certain ecological habitat.

The species of Erythemis, as larvae, live in stagnant water, and Hetaerinas live in running water. Streams offer a greater variety of ecological conditions than fresh-water ponds offer.

Hetaerinas as imagoes are closely bound to the streams which make their larval home. Their dispersal to new habitats is doubtless rare and accidental.

It is entirely conceivable that a single fertile female in a certain instance might furnish the entire original Hetaerina invasion of the headwaters of some small mountain creek. Here the species, by direct descent from this single female, might maintain itself without any admixture of new blood for many generations. After a period of time, the infrequent and accidental invasion by new blood would be quickly swamped in the mass of old stock. Individuals of Erythemis, on the other hand, are wanderers, and the Erythemis fauna of any pond may be partly or largely descended from new immigrants of the preceding season, their descendents in turn scattering with the dry season and many of them visiting other ponds when the period of ovipositing comes.

Specimens of any species of Erythemis are remarkably uniform throughout the range of the species. I know of only one exception, that of the Guatemalan specimens of *E. mithroides,* which are distinctly larger than South American specimens of the same species. On the other hand, a number of cases of differences in a species of Hetaerina in its range can be cited. The most striking case I recall is the remarkably large, dark specimens of *cruentata* occurring at a high elevation in the isolated Santa Marta Mountains of Colombia. Almost equally striking is the large, dark form of *macropus* at an elevation of 2,230 feet in Peru. On a larger scale, but less distinctly marked, are the pale forms of *caja* and *macropus* east of the Andes in western Venezuela, as compared with the dark forms west of these mountains.

LOCALITIES NOT HERETOFORE DESCRIBED IN THIS OR OTHER PAPERS

1. Bejuma, Department of Caraboba, Venezuela. In describing the country about Bejuma in Occasional Papers, No. 130, several swamps or shallow ponds which lie in the valley were not mentioned. One of these is about one mile east of Bejuma. The area is about an acre, surrounded by thorny mimosas inside which grew several species of sedges, water hyacinth, another aquatic with three yellow petals, orange at the base, another with small purple flowers, and a small yellow Utricularia. This pond was in the last stages of drying up when we saw it on February 16, 1920, with very little open water, which had a maximum depth, with the mire in which one sank, of about three feet.

2. Encontrados, Department of Zulia, Venezuela. Encontrados is on the right bank of the Catatumbo River and is the lower terminus of the Gran Ferrocarril del Tachira. Its elevation is about 138 feet, and it lies in a low, flat country of brushy forest, large areas of which near town and along the railroad are now in grass, bananas, cocoa, and some sugar cane. Just above town is a long lagoon filled with aquatics and bordered with brush and pastures where odonate life, especially strong-flying libellulines, was very abundant. Along the river below town are many flats, covered with water during the rainy season, and during the dry season consisting of stretches of mud, grass, and bushes, with shallow pools. Three or four kilometers below town on the left river bank is a caña eight to twelve feet wide, mostly in the sun,

muddy and with many logs, the banks high and grass-covered, and the adjacent country in corn, bananas, and abandoned fields, with occasional patches of forest with heavy brush and frequent dense Heliconia growths. These bits of forest are often bordered and sometimes completely surrounded by an impenetrable jungle of spiny shrubs overgrown with razor-edged sawgrass.

3. Las Delicias, Department of Magdalena, Colombia. A woodpile on the banks of the Magdalena about 120 leagues above Barranquilla and two or three leagues below Boca de Rosario. The surrounding country is the usual low, level-lying river plain of the lower Magdalena.

4. Zambrano, Colombia. A village on the Magdalena between Calamar and Magangué in the usual level, pastured land of the lower river valley.

THE PHYLOGENY AND THE GEOGRAPHICAL DISTRIBUTION OF THE GENUS ERYTHEMIS (ODONATA)

By Clarence Hamilton Kennedy

The following paper has been prepared at the suggestion of Mr. E. B. Williamson, who, in the accompanying paper, has presented the systematics of this group. The material has been arranged to parallel the arrangement in the writer's article[1] on the genus Libellula, and is one of a series of papers which it is planned to present on the relationships of the American Odonata.

Time is not available and material is not at hand for a definition of the relationships of this genus to the other genera in the Libellulinae. For this reason, the writer has followed the definition of groups presented by Ris,[2] who followed Calvert.[3] The penes of Lepthemis and of all the species of Erythemis recognized by these authors have been examined. Ris includes in this group only one other genus, Rhodothemis of the East Indies. As no material of this species is in Mr. Williamson's or the writer's collections, it has not been studied. However, Ris figures its wings and gives a detailed description of its peculiarities. From this account it is evidently the least specialized of the three genera in the armature of the legs, which have the spines of the femur less developed; and in the venation, which is "reduced" as it is in *credula* only of the American genera. The location of Rhodothemis, the least specialized member of this series, in the East Indies suggests an Oriental origin for the group as a whole and that the stock of the American genera at some time in the past has spread into its present habitat. As the majority of the species are tropical, the spreading into America may have taken place when the Asia-Alaska land-bridge had a climate suitable for such species, which must have been in Pre-Miocene times. The other possibility is that they came across from Africa, but so far we have not recognized any African relatives of the group. *Credula,* the most primitive of the American species, has not been found north of Panama and St. Thomas, while the two species that are found farthest north, *haematogastra*[4] and *simplicicollis,* are two of the most specialized, which distribution seems to confirm a southern or tropical entrance into America.

The homologies of the lobes of the penis in the genera Libellula, Sympetrum, Orthetrum, and Orthemis were worked out by the writer in a previous article.[5] All parts that were defined for these appear also in the series

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[1] The Phylogeny and the Geographical Distribution of the Genus Libellula (Odonata). *Ent. News,* XXXIII, pp. 65-71, 105-111, 1922.

[2] "Libellulinen," Fasc. XIII, pp. 591-608 in Coll's Zool. du Selys, 1911.

[3] Nomenclature of Certain North American Odonata, *Ent. News,* XVII, pp. 30-31, 1906.

[4] Williamson doubts the Georgia records of this species.

[5] The Morphology of the Penis in the Genus Libellula. *Ent. News,* XXXIII, pp. 33-40, 1921.

of Erythemis penes. In comparison with the penes discussed in the above article, the first peculiarity in the Erythemis penes that strikes one is the development of a small, chitinized, two-lobed hood over the medial lobes. Apparently, it is a specialization of Erythemis and its near relatives. It appears in all the species except *credula,* in which species the penis is most like that organ in the less specialized members of Libellula, Sympetrum, etc. As this species has the generalized characters of venation found in Rhodothemis, we have considered it the most primitive of the American species of the Erythemis series. Even though it lacks this hood, there is no doubt that *credula* belongs in or next to Erythemis, as it has in a pair of tubercles the homologue of the hood in the other species (see fig. 8).

The American species, by penis characters, divide into four groups which are exactly equivalent with the groups as outlined by Calvert and Ris on other characters. To these, *Rhodothemis rufa* may be added as an extra group. In the key I have placed it first as Group I because of its generalized characters. The fifth and largest group is composed of species with penes so much alike that no good characters appear on which to divide them further, though they seem to fall into two sub-groups on the shape of the abdomen. The writer would be inclined to call the whole series of five or six groups Lepthemis and would consider the individual groups as subgenera, which could be given generic rank by those who wish to use smaller genera. Lepthemis, for the whole series from *Rhodothemis rufa* to *Erythemis haematogastra,* is no more comprehensive, in the writer's opinion, than Libellula for the series of species included in the latter by Ris and later by the writer. The comprehensive genus would have to be Lepthemis because of the priority in the use of that name by Hagen.[6] The groups may be outlined as follows:

1. Oriental (Rhodothemis).....Group I—*rufa*

1′. American (Lepthemis and Erythemis)..... 2.

2 (1′). Hood over medial lobes undeveloped (represented by two tubercles)..... .....Group II—*credula*

2′. Hood over medial lobes developed into an arched two-lobed affair..... 3.

3 (2′). Posterior lobe of penis lacking, the three cornua fused into a single conspicuous, terminal lobe..... 4.

3′. Posterior lobe present..... 5.

4 (3). Lateral lobes and cornual lobe parallel to the axis of the penis (Lepthemis)... .....Group III—*vesiculosa*

4′. Lateral lobes and cornual lobe bent across the axis of the penis (Mesothemis).. .....Group IV—*collocata simplicicollis*

5 (3′). Abdomen not especially slender (Erythemis)..... Group V A—*peruviana mithroides attala*

5′. Abdomen slender (Erythemis)...GroupV B—*plebeja carmelita haematogastra*

[6] Synopsis of the Neuroptera of North America, p. 160, 1861.

This series of eleven species, small as it is and with several of its species occupying nearly identical habitats, is so non-committal as to its origin and routes of migration that these will have to be worked out by some less direct method than that of a study of the degrees of specialization of the individual species. The latter method gives results where the group is large and many connecting links remain.

It is possible that *vesiculosa* belongs near Group V B and that the loss of the posterior lobe has occurred independently in Groups III and IV. A careful check of the other characters should decide this.

We have also the problems of the generic rank of Mesothemis and the value of its two forms, *collocata* and *simplicicollis*. By penis characters alone, Mesothemis is as valid a genus as Lepthemis. In fact, the specialization of the fusion of the lobes of the cornua and the loss of the posterior lobe has gone farther from the Erythemis type that is found in the majority of the Erythemis species than it has gone in the Lepthemis penis. The forms, *collocata* and *simplicicollis*, as viewed in the light of recent work by geneticists on other insects, are probably good species. Just how nearly homozygous each is under all circumstances will have to wait until a careful study can be made of the two forms where their habitats overlap.

EXPLANATION OF PLATE I

Figs. 1-6, by E. B. Williamson.

Figs. 7-16, by C. H. Kennedy.

Figs. 1-6, *Erythemis carmelita* n. sp. Figs. 1-4, type male; figs. 5-6, allotype female. Fig. 1, accessory genitalia of segment 2 in lateral view; fig. 2, same in latero-ventral view; fig. 3, abdominal appendages in lateral view; fig. 4, inferior appendage in ventral view; fig. 5, vulvar lamina in lateral view; fig. 6, the same in antero-ventral view.

Figs. 7-16, penes of species of Lepthemis and Erythemis. Each pair of figures represents, in the upper member, a lateral view of the tip or third segment of the penis and, in the lower member, the same view with the lateral lobe removed to show the cornual and medial lobes. Where not otherwise indicated, the specimen is in the collection of Mr. E. B. Williamson. The lettering of the figures is that used in "The Morphology of the Penis in the Genus Libellula," Ent. News, XXXIII, pp. 33-40, as follows: H = hood, M = medial lobes, C = cornua, L = lateral lobes, P = posterior lobes.

Fig. 7, *Lepthemis vesiculosa,* Dutch Guiana, O. S. U. coll.; fig. 8, *Erythemis credula,* Pitch Lake, Trinidad; fig. 9, *Erythemis peruviana,* Tucacas, Falcon, Venezuela; fig. 10, *Erythemis mithroides,* El Banco, Colombia; fig. 11, *Erythemis attala,* Fundacion, Colombia; fig. 12, *Erythemis collocata,* Fresno Beach, California; fig. 13, *Erythemis simplicicollis,* Columbus, Ohio; fig. 14, *Erythemis plebeja,* Fundacion, Colombia; fig. 15, *Erythemis haematogastra,* Fundacion, Colombia; fig. 16, *Erythemis carmelita,* El Banco, Colombia.

E. carmelita n. sp.; figs. 1-4, type male; figs. 5-6, allotype female.

Penes of the species of Lepthemis and Erythemis, figs. 7-16.

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The Genus Gyrotoma

BY

CALVIN GOODRICH

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

THE GENUS GYROTOMA

By Calvin Goodrich

The genus Gyrotoma has received no systematic treatment in fifty years. Since 1873, when Tryon's monograph was published, three collectors, T. H. Aldrich, A. A. Hinkley and H. H. Smith have taken many hundred times more specimens than were available for study by the naturalists who described the species. For the present inquiry I have examined material from several sources. The collection made by Mr. Smith and now in the Alabama Museum of Natural History is unrivaled, and, because of the water-power development in the Coosa River, flooding the shoals in which Gyrotomae live, it can probably never be duplicated. Acknowledgments are due to the Alabama Museum, the U. S. National Museum, Dr. Bryant Walker and Miss Mina Winslow. Without their aid this work could not even have been attempted.

The Record

Dr. Isaac Lea was the first descriptive naturalist to receive specimens of Gyrotoma. These he described as *Melania excisa* and *Anculosa incisa,* suggesting at the same time the generic term Schizostoma. When later he found the name already in use for a fossil he changed it to Schizochilus. In the meanwhile Shuttleworth had defined his genus. The fossil Schizostoma as well as the Schizostoma of Lea finally were forced into the synonymy. The good doctor, one of whose picturesque qualities was tenacity of purpose coupled with a certain fervid plausibility, sought to dig his original name out of its grave. The canons of nomenclature do not allow for cases of resurrection, and Gyrotoma has had to stand as the true generic designation.

Lea's specimens were sent to him by Dr. B. W. Budd. Because these shells were few in numbers, the condition of many of them that of drift material, their place of origin confused, and because Dr. Budd was himself interested in conchology and hardly likely to take ten or twenty shells where he might have gathered thousands, it is improbable that he was the collector. About the same period, Gyrotomae came to Mighels and apparently from the same correspondent. This was 1841, possibly 1842, to 1845. All the forms were of the Wetumpka aspect. In July, 1845, Shuttleworth described two species. His specimens had been collected by Rugel, who apparently visited the Coosa River at Greensport or thereabouts and may have gone as far down as Childersburg. It was not until 1904, when Mr. H. H. Smith began to explore the Coosa systematically, that Shuttleworth's one "good" species was found by an American collector. This history is an illustration of the casual, one might say accidental, collecting of early-day zoology in America.

About fifteen years after Dr. Budd's sendings, Gyrotomae, from the reaches between the Yellowleaf Creek of Shelby County and Fort William Shoals, Talladega County, were taken by Dr. Schowalter of Uniontown, Alabama. It would seem that Dr. William Spillman of Columbus, Mississippi, visited the Coosa River in the same places and at about the same time, and it is possibly fair to infer that the two were together. Lea and Anthony erected eighteen species from this new material and Reeve described still others under names supplied by Anthony.

Reeve's monograph of Melatoma appeared in 1860-61. Swainson had established Melatoma as a subgenus of Melanopsis Lam. Reeve believed it to be the same as Gyrotoma. Tryon says that Melatoma "is actually an exotic marine shell." The connection of Anthony's name with Melatoma was an error. Reeve's illustrations are excellent and in most instances the species can be recognized from these pictures. But the descriptions, written by Reeve, convey little information of value. In two of the descriptions no mention is made of the fissure, the distinctive character of Gyrotoma. In the case of one species the slit is described as "small, almost obsolete"; in one as "slightly channelled"; in two, "moderate"; in two, "broad"; in ten, "deep"; in two, "rather deep"; in one, "very deep." The reader of Reeve is reminded of the childhood question, "How deep is a well and how long is a string?"

The Anthony types described in this monograph are in the Museum of Comparative Zoology at Cambridge, Massachusetts. Reeve's own types are in the British Museum and these were examined by Dr. Bryant Walker and compared with material taken by Mr. Smith.

In 1862 Brot issued a "Catalogue Systematique des Especes qui Composent la Famille des Melaniens." He spoke about the genus Gyrotoma being little known in Europe and of the sparse distribution of examples among the collections. He indicated a suspicion that these shells might be variations or mutations of "certain species of the group of *M. Haysiana*, which live in the same locality." A very just criticism was made of authors who pictured their species in the conventional manner and failed thereby to show the "characteristic notch." Lacking a sufficient number of specimens and illustrations more decisive Brot declined to pass upon the validity of the genus. It is this catalogue I have mentioned later in the text as the Brot list.

In 1869, Dr. James Lewis (4) made a list of the Gyrotomae as part of a catalogue of mollusks of the Coosa River. Tryon's (10) study of the genus appeared in 1873. For half a century it has been a guide for the collector of Pleuroceridae. It erred in the synonymy. The classification was artificial. Too many species were recognized as valid. But when it is remembered that thirteen species of Gyrotoma had been erected from just thirteen specimens and that comparatively few additional shells were available for Tryon's study, that Shuttleworth's species were unknown in this country and Mighels' types had been destroyed by fire, any sharp criticism of Tryon's work with the genus would be unfair.

The next writing upon the subject was by Mr. A. A. Hinkley, whose paper (2) appeared in 1904. He had collected the year before in the

Coosa at Fort William Shoals, Wilsonville and Wetumpka. He distributed a great number of specimens, many of which I have had the opportunity to examine.

Hannibal (2, p. 179) recognized Gyrotoma as a genus and set down Goniobasis as a subgenus. Under the name *Gyrotoma olivula excisa* (Lea) he threw together all the forms that are mentioned in Tryon as being deep-fissured, eighteen species in all. Twenty-two, described as having short or shallow fissures, suffered telescoping under the designation *Gyrotoma laeta incisa* (Lea). Mr. Hannibal was bold, but not without a few misgivings. Preparatory to a prodigious scrambling of the Pleuroceridae he wrote, "It is not anticipated that this treatment will meet with general approval in every instance."

The Alabama Museum collection of Gyrotomae is, of course, unparalleled. It contains thousands of specimens carefully labelled and so painstakingly cleaned that color and sculpture can be made out quickly and with certainty. Notes by Mr. Smith upon his labels and observations he made in his correspondence with Dr. Walker have been invaluable in this study.

THE ENVIRONMENT

The genus is confined to the Coosa River. It has not been found even within the mouths of creeks flowing into the river. The nature of the habitat supplies the explanation. Mr. Smith repeatedly wrote of Gyrotomae as living in rapid heavy currents. Speaking of the genus at Wetumpka he said that it was "almost confined to swift water, and those specimens in pools do not look healthy and are apt to be deformed." A permanent habitat of this kind is rarer among Pleuroceridae than is generally supposed. Io and Anculosa do occupy the swifter parts of rivers, the old as well as the young, but most species of Pleurocera are to be found in quiet water. *Pleurocera unciale* (Hald.), a characteristic east Tennessee species, is in the main part of streams only while partly grown. The adults seek the pools and banks. I have noticed the same thing of *Goniobasis livescens* (Menke) in Ohio, Michigan and Indiana. Colonies of *livescens* are found upon wave-beaten rocks in Lake Erie, but far larger colonies inhabit places much more protected. The ordinary bulbous form of *livescens* lives plentifully in rapids of the upper Wabash River. A depauperate form of the species was collected by Hinkley under stones in the lower part of the river. Such a site, corresponding to that in which Gyrotoma flourishes, was an unhealthy one for a species probably the most adaptive of all Goniobases.

DISTRIBUTION

Gyrotoma first appears in the Coosa at Lock 2, St. Clair County. The only species there and about as far down as the mouth of Yellowleaf Creek of Shelby County is *pyramidatum*. In the short distance between this point and the foot of Peckerwood Shoals, Talladega County, occur five species which are confined to these reaches, namely, *amplum, cariniferum, spillmanii, lewisii* and *hendersoni*. The second and the last of these five are known from Fort William Shoals only. *Alabamensis* is first met with sparingly

on Peckerwood Shoals and disappears below Duncan's Riffle, Chilton County. *Walkerii* has a somewhat shorter range, Weduska Shoals, Shelby County, to Butting Ram Shoals, Coosa County. Five species occur at Wetumpka. Their up-river range from this point is: *Excisum,* to Three-Island Shoals, Talladega County; *laciniatum,* to Fort William Shoals; *incisum* and *pumilum* to Weduska Shoals; *pagoda,* to The Bar, Chilton County.

The localities for Gyrotoma mentioned in this paper are here set down in their order, up-stream to down-stream, the county designations being given as upon Mr. Smith's labels, though the river in most of these places is the border between counties:

Lock 2, St. Clair County.
Ten-Island Shoals, St. Clair County.
Lock 4, St. Clair County.
Riverside, St. Clair County.
Truss Shoals, St. Clair County.
Clarence Shoals, St. Clair County.
Hall's Island, Talladega County.
Yellowleaf Creek (upper), Shelby County.
Three-Island Shoals, Talladega County.
Fort William Shoals, Talladega County.
Peckerwood Shoals, Talladega County.
Weduska Shoals, Shelby County.
Cedar Island, Chilton County.
Adam's Ferry, Chilton County.
Yellowleaf Creek (lower), Chilton County.
Butting Ram Shoals, Coosa County.
Higgin's Ferry, Chilton County.
Wetumpka, Elmore County.

RELATIONSHIPS AND GENERAL CHARACTERS

The affinities of Gyrotoma are with certain Goniobases which should be separated from that genus. These mollusks are characterized by large shells and large opercula. They have the same wide aperture of Gyrotoma and the same microscopic sculpture. The group has not been carefully studied, but these species unquestionably belong to it: *Goniobasis impressa* Lea, *laeta* Jay, *showalterii* Lea (1860), *lewisii* Lea, *bellula* Lea and *ovalis* Lea. Probably others are *gratiosa* Lea and *lachryma* Anthony, which Tryon (10, pp. 342, 343) assigned to Eurycaelon. Occasionally all these species develop incipient fissures. Mr. Smith collected several specimens with fissures nearly as large as in *pyramidatum* and *incisum* and yet, in other regards, retaining their usual Goniobasic features. Every one has a deposit of callus at the top of the columella. This is found in typical Gyrotoma. One specimen of *Goniobasis showalterii,* in addition to having a very small fissure, has a girdle for about 5 mm. upon the body whorl.

After a little study it becomes apparent that Gyrotoma is not a compact genus whose members can be traced with certainty to a common origin. It differentiates into five natural groups. *Pyramidatum* and *spillmanii* form one of these groups. A second consists of *pagoda, pumilum, alabamensis* and *cariniferum.* These two groups would appear to have developed from *Goniobasis laeta* or some other species very like it. *Lewisii* and *hender-*

soni constitute a third group whose relations with *Goniobasis impressa* are quite plain. *Incisum, walkeri* and *amplum,* though not always easily to be distinguished from one another, manifestly differ from the other species of Gyrotoma. The fifth group is made up of *excisum* and *laciniatum.* Their well-fixed characters and their long range in the river justify the belief that they are the oldest species of the genus. I have been unable to find in Goniobasis any species definitely ancestral to the *excisum* and *incisum* groups.

The specific value of some of the races of Gyrotoma, I recognize, is open to question. It requires considerable familiarity with them, and perhaps the habit of mind which goes with studying a family of extreme complexity, to be altogether confident as to the identifications of certain forms, *incisum* and *amplum* for example. Characters overlap. Characters sometimes prominent in one locality fade nearly to invisibility in another. It might possibly be doubted whether variations in the depth of the fissure, being largely a matter of size, warrant recognition beyond subspecific rank.

But difficulties arise in attempting a wholesale lumping of the Gyrotomae. One would have to ignore distinct differences in many of the young and these differences point to ancestral distinctions. The derivation of one group is clearly not the derivation of two other groups. A fourth and a fifth group cannot be traced to any known form. Lumping would consolidate forms independently developed, adding confusion instead of achieving simplicity.

A possibly important question in connection with Gyrotoma is whether it is a genus in course of developing or disappearing. J. C. Willis (11, p. 166) recites three explanations for endemism which he chooses to consider rivals: "(1) That endemics are very specialized species (and genera) suited only to the areas upon which they have been found; (2) that they are old species (and genera) which have been driven into quiet nooks or left in odd corners by the competition of better adapted species; and (3) * * * that in general they are young beginners, descended from the 'wides'." Willis' argument is largely devoted to the advocacy of the third explanation as the one for the majority of cases. I see no reason why all three hypotheses may not apply with almost equal force. The Vitrinizonites of the southern Appalachians may be examples of highly specialized forms narrowly confined to particular localities. An illustration of one form of a relict race is given by Ortmann (7, p. 3-6). *Margaritana margaritifera* (L.) occurs in the headwaters of the Schuylkill River, and in no other place in Pennsylvania. The shells are confined to cold trout streams and in the parts of these that are 800 to 1200 feet above sea level. "The Pennsylvanian area of this species is not only the most southern extension of its range in eastern North America, but it also has the peculiarity of being the only one to the south of the Terminal Moraine. Thus it may be regarded as a part of the Glacial Preserve (refugium) of this species." The great numbers in which Gyrotomae occur in the Coosa River, their variability which is so characteristic of a genus that has not yet become "fixed" and their failure, for all their numbers and apparent vigor, to get beyond a restricted habitat, convince me that they represent "young beginners descended from the 'wides'."

The observations of skilled zoologists with a great deal of field experience have been warnings against giving hastily the emphasis of specific names to the thirteen species herein recognized. Ortmann (6, p. 512) says, "Isolation is, in my opinion, a necessary factor in the differentiation of species and I do not think that a case ever will be discovered where two closely allied species possess precisely the same distribution." Jordan's law (3, p. 547) lays it down that, "Given any species in any region the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort." More briefly Ruthven (9, p. 192) declares that "directly related forms on any line of descent occupy neighboring environments."

Several of the closely allied species of Gyrotoma do appear to have exactly the same distribution to all intents and purposes. Unfortunately I have not all the details of Mr. Smith's collecting experiences. But the impression is obtained from his letters and from the notes accompanying the labels that a given reef of a series of shoals is not occupied by a heterogeneous assemblage of mollusks, but by some particular form of the genus, each such colony being cut off from other colonies of the genus by deep water, quiet water, rolling gravel, by mud or by rocks that in dry seasons are exposed to the air. Thus within a small area, too small to be especially observed by the collector not upon the lookout for it, there may be a distinct differentiation of locality, small barriers with as powerful an influence upon Gyrotomae as barriers quite plain to the eye—all the effects of isolation.

THE OPERCULA

The opercula of all Gyrotomae are large, leathery, dark red to dark brown. The growth lines are crowded. The surface in instances is more or less marked with microscopic wrinkles which tend to form irregular lines or bands at right angles to the growth lines. The nucleus is indented. Opercula wear down quickly and become irregular in shape so that in the cases of adults the shape is frequently quite different from that in the young. In old specimens the nucleus or area of the inner whorls is often completely eroded away.

In this study the opercula were first examined in connection with the shells. Later they were more carefully re-examined and compared with one another, species by species. There are recognizable differences, but I cannot feel that they are of great importance. The opercula of *pyramidatum, spillmanii, lewisii* and *hendersoni* are quite broad and with the inner whorls well within the operculum. *Pagoda* has a narrower, darker operculum, the apex more blunt. In *pumilum, alabamensis* and *caviniferum* the opercula are mostly of the *pagoda* form, but have become slightly broader and noticeably larger. The opercula of *excisum* and *laciniatum* are practically identical, being smaller than in *pyramidatum*, darker, thinner and broader than in *pagoda*. The inner whorls are tightly coiled rather than loosely. The operculum of *incisum* are thin, ragged, variable in shape. In *walkeri* and *amplum* the opercula are much the same as those of *incisum*, but in *amplum*

they appear to run decidedly larger and this is not to be explained by the size of the aperture. The nucleus of all except *pyramidatum* is quite close to the left margin and near the base.

A few opercula have been illustrated, but without any intention of accenting differences. Many of the differences are possibly due to variations in the erosion to which this feature is subjected in strong currents. The opercula of quite young Gyrotomae are very nearly uniform.

GENUS GYROTOMA SHUTTLEWORTH

Schizostoma Lea, (non Bronn, 1835), Proc. Amer. Phil. Soc., II, 1843, p. 242; Trans. Amer. Phil. Soc., IX, 1844, p. 26; X, 1848, pp. 67, 93; I, n. s., 1852, p. 295; Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 186; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, pp. 218, 243, 245, 246; VI, 1866, p. 152; Obs. Gen. Unio, IV, 1848, pp. 26, 67, 93; V, 1852, p. 51; IX, 1863, pp. 40, 65, 67, 68; XI, 1867, p. 108; Tryon, Amer. Journ. Conchol., I, 1865, pp. 114-116, 131; II, 1866, p. 134; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, pp. xxiii-xxvii, xxxiii, xxxv, xxxix, xlvi, 351; Hinkley, Nautilus, XVIII, 1904, p. 40, 41.

Gyrotoma Shuttleworth, Mittheil. der Nat.-forsch. Gesellsch. in Bern., July 22, 1845, p. 88; H. & A. Adams, Genera, I, 1854, p. 305; Gray, Guide to Mollusca, I, 1857, p. 103; Chenu, Man. de Conchyl., I, 1859, p. 293; Anthony, Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 53; Binney, Check List, 1860; Brot, List, 1862, p. 27; Tryon, Monog. Strepom., 1873, pp. xv, xviii, xxiii, xxiv-xxvii; Paetel, Cat., 1888, p. 361; Pilsbry, Proc. Acad. Nat. Sci., Phila., 1896, p. 497; Hannibal, Proc. Malacol. Soc., X, 1912, p. 179.

Schizochilus Lea, (non Gray, 1850), Trans. Amer. Phil. Soc., X, n. s., 1852, p. 295; Obs. Gen. Unio, V, 1852, p. 51; IX, 1863, p. 67; Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 186; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 245; Tryon, Monog. Strepom., 1873, pp. xxiv, xxxiii.

Melatoma Anthony, Gray, Proc. Zool. Soc. of London, 1847, p. 153; Woodward, Manual, 1851, p. 131; Reeve, Conch. Icon., 1860.

Apella Mighels, MS., 1860.

"Shell turreted; columella incurved, thickened above by an intermarginal callus; aperture oval, somewhat spread out (effuse) at the base; lip simple, sharp, with a narrow fissure, deeply notched.

"Animal. ————; operculum corneous, spiral."—Shuttleworth.

GROUP OF *Gyrotoma pyramidatum*

Rather heavy, pyramidal especially in the young, sometimes nodose, smooth to striate; fissure shallow, oblique, not exceeding 8 mm. in depth; girdle not always conspicuous; aperture ovate; sinus not pronounced; bands usually four and of equal width.

Gyrotoma pyramidatum Shuttleworth

Pl. I, figs. 1, 2, and 3

Gyrotoma pyramidata Shuttleworth, Mittheilungen der Naturforschenden Gesellshaft in Bern, No. 50, July 22, 1845, p. 88; H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 329; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Gyrotoma conica Shutt. (?), Troschel, Gebiss der Schnecken, I, 1857, p. 111, pl. 8, fig. 12; Brot, List, 1862, p. 27; Tryon, Monog. Strepom., 1873, p. 380.

Gyrotoma laeta incisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 182.

Schizostoma pyramidatum Shutt., Tryon, Monog. Strepom., 1873, pp. xv, 365; Lewis, Fauna of Ala., 1876, p. 23.

Description: Shell pyramidal, heavy, olivaceous or blackish, concentrically sulcate-costate, more often with rough knobs (nodules); banded with brown, apex eroded; whorls 5 or 6; fissure short, broad, columella thickened tuberculously above.

Length, .9; breadth of the ultimate whorl, .412-.5 of an inch. Length of aperture, .312; length of fissure, .1 of an inch.

Obs.—Somewhat resembles *Melania canaliculata;* varies as the preceding (*G. ovoidea*).

A few specimens . . . occur among others, with the upper whorls acutely carinated, ridges and furrows fewer and almost obliterated; epidermis paler and apex little eroded.—Shuttleworth.

This is the first Gyrotoma appearing in the river. Mr. Smith's highest station for it was Lock 2, which is at the head of Ten-Island Shoals, between St. Clair and Etowah counties. Shuttleworth in his preface states that Rugel collected in the Coosa River, near Wetumpka. But there is sound reason for believing that this is an error. The species was never taken by persons who collected from Wetumpka as far up the stream as Fort William Shoals. The nodulous character of the shells sent to Europe is a peculiarity almost entirely confined to Pleuroceridae upon and near Ten-Island Shoals. Not only are the Gyrotomae of this locality so marked and the so-called Eurycaelon, but also Anculosae and Goniobases. In a letter to Dr. Walker, Mr. Smith said that even certain Pleurocerae are likewise affected. The oddity is not in mollusks collected farther up the river. It tends to disappear below these shallows.

The fissure[1] is shallow, oblique, and is angled rather than curved or sinuous as in *incisum,* also having a short fissure. At Lock 2, the fissure has a maximum depth of 3 1-2 mm. At Hall's Island, it is as deep as 5 mm. and is not so oblique as in material from the higher locality. Obliqueness is more pronounced in young specimens than in old; in juveniles the fissure is a mere notch. The hem is only faintly marked, being of much the same color as the rest of the shell; it is to be observed in hardly more than half the shells.

The pyramidal aspect is that mostly of individuals one-half to three-fourths grown. The base is usually rounded in adults. Knobs, when present, give the shell a squared, four or five-sided appearance, and are not spaced regularly. Color[2] ranges from honey-yellow to raw-umber. The prevailing banding formula is four bands of equal width. The aperture is ovate. The white or bluish-white columella is smoothly rounded, slightly

[1]In the literature of Pleurotomariidae the fissure is spoken of as the "anal sinus" and the girdle or hem as the "sinus band". I have preferred to use the terms of the early writers upon Gyrotoma even if the others be more descriptive. Doubtless as in the marine mollusk the fissure of Gyrotoma serves a purpose for the discharge of excreta.

[2]The colors assigned in this study are according to "Color Standards and Color Nomenclature" of Ridgway, 1912. While a fairly large number of names have been given in order to be as exact as possible it will be remarked that the color range in this genus is rather limited.

produced at the base and has a node at the fissure. It attains full development earlier in this species than in any other of the genus. The outer lip is sinuous. The largest *pyramidatum* measured, which probably would have eight whorls if uneroded, is 21 x 11 1-2 mm.

A young specimen from Lock 2, having five whorls, is conic, carinated at the periphery of the whorls, sharply angulate of base. The whorls are flat and without folds. The columella is undeveloped. There is scarcely more than an indication of fissure. Bands are three in number.

Mr. Smith's lowest locality for *pyramidatum* is Hall's Island, Talladega County. There are two specimens in the Schowalter Collection which I judge to be this species. The locality is mouth of Yellowleaf Creek (Shelby County). This is a few miles below Hall's Island.

Dr. Walker compared specimens taken by Mr. Smith with types of *pyramidatum* and *conica* in Geneva and found them to be the same. *Conica* does not appear to have been formally described. Dr. Walker, who came upon material in the Geneva Museum so labeled, suggests that the remarks at the end of the description of *pyramidatum* might have been intended to refer to this form.

Gyrotoma spillmanii (Lea)

Pl. I, figs. 4 and 5

Schizostoma Spillmanii Lea, Proc. Acad. Nat. Sci., Phila., XIII, 1861, p. 54; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 250, pl. 35, fig. 55; Obs. Gen. Unio, IX, p. 72, pl. 35, fig. 55.

Schizostoma babylonicum Lea, Tryon, Monog. Strepom., 1873, p. 369.

Gyrotoma Spillmanii Lea, Paetel, Cat., 1888, p. 362.

Gyrotoma laeta incisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 182.

Schizostoma Wheatleyi Lea, Proc. Acad. Nat. Sci., Phila., XX, 1868, p. 153; Journ. Acad. Nat. Sci., Phila., VI, 1868, p. 342, pl. 54, fig. 27; Obs. Gen. Unio, XII, 1868, p. 342, pl. 54, fig. 27; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 169; Lewis, Fauna of Ala., 1876, p. 23.

Description: Shell striate, subcylindrical, rather thick, yellowish-brown, imperforate; spire obtuse, conoidal; sutures impressed; whorls six, very much banded, flattened, the last large; fissure oblique and rather short; aperture large, ovate and banded within, obtusely angular at the base; columella white, thickened above; outer lip sharp and sinuous.

Operculum ovate, spiral, rather large, dark brown with the polar point near to the left edge, about one-fifth above the basal margin.

Habitat: Coosa River, Alabama; Dr. F. R. Showalter.

Diameter, .48; length, .92 of an inch.—Lea.

The fissure of *spillmanii* is like that of *pyramidatum* from Hall's Island. The young, though larger, whorl for whorl, are hardly to be separated from juvenile *pyramidatum*. The types carry the resemblance because they have unusually shallow fissures for adult *spillmanii*. But this species in general is a larger, coarser race, more boldly sculptured, pyramidal only in the adolescent stage and so stepped at the suture as to suggest to Tryon that it was the same as *babylonicum* Lea. I think it can stand as a species, related closely to *pyramidatum* or springing at no great distance in time from the same ancestral form.

The fissure is 3 to 8 mm. in depth, always oblique. Of 20 specimens in one lot, 11 have a wide fissure, in 9 it is narrow. Most of these latter individuals show signs of injury or deformation at the top of the whorl. The girdle is cord-like, irregular, more or less conspicuous by reason of differing in color from the body of the shell.

Spillmanii is heavy, nodulous, though sometimes smooth, frequently constricted, slightly plicate upon the early whorls. Fourteen shells in the lot of 20 have stout, revolving folds, 5 have folds nearly obsolete and 1 is smooth. Growth lines are fine to coarse, the scars of rest periods being quite prominent. An adult with three remaining whorls measures 25 x 13 1-2 mm. Color varies from sulphine-yellow to buffy-citrine. Bands are four, all of the same width. This is the prevailing formula. Variations are modifications of this formula. The aperture is wide, ovate, the sinus at the base scarcely noticeable. The columella is white, thick, broadly rounded and has a heavy callous at the top. The outer lip is slightly sinuous.

A young shell of five whorls is pyramidal, obscurely plicate, subangulate at the base. The columella is small, undeveloped; the fissure a mere curving indentation. A full grown shell would have eight whorls probably if uneroded.

The more nearly typical shells examined in the Alabama collections were taken by Dr. Schowalter and the locality given is "Coosa River, Shelby County, Ala." A smooth form, less robust and with a shallow fissure corresponding with the types, was taken by Mr. Smith in Peckerwood Shoals. No other localities are known.

The type of *wheatleyi,* save in point of size, looks very much like *spillmanii* in form, sculpture, bands and fissure. This seems to be the only shell of the kind that was collected by Schowalter. Mr. Smith found two small shells which I feel convinced are dwarfed *spillmanii,* but curiously they differ greatly from Lea's *wheatleyi.*

In his formal description, Lea mentions Dr. Schowalter as the collector from whom he received *spillmanii.* Later, under "observations," he says, "I have a number of specimens, chiefly young, from Dr. Spillman and a fine suite of different ages from Dr. Schowalter." All these shells are in the United States National Museum. Certain ones, with a label (1) pasted upon them, I have ventured to assume to be the types. They correspond to the Schowalter shells in the Alabama Museum collection. With them are two specimens of *G. pagoda* Lea and a third Gyrotoma broken and indeterminate. These probably are the sendings from Dr. Spillman. Three other lots under the name of *Spillmanii* agree with the Schowalter mollusks and a fifth consists again of *pagoda.*

GROUP OF *Gyrotoma pagoda*

Conical to globose, smooth to striate, the young carinate and more or less obscurely plicate; fissure oblique to straight, not exceeding 10 mm. in depth; girdle of varying size and color; aperture more frequently elliptical than ovate; sinus usually distinct; bands, ordinarily four and equidistant.

Gyrotoma pagoda (Lea)

Pl. I, figs. 6, 7, 8, and 9

Schizostoma pagoda Lea, Proc. Amer. Phil. Soc., IV, 1845, p. 167; Trans. Amer. Phil. Soc., X, 1848, p. 93, pl. ix, fig. 52; Obs. Gen. Unio, IV, 1848, p. 93, pl. ix, fig. 52; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 247; Obs. Gen. Unio, IX, 1863, p. 69; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 169; Tryon, Monog. Strepom., 1873, pp. xv, 365; Lewis, Fauna of Ala., 1876, p. 23.

Gyrotoma pagoda Lea, Chenu, Manuel, I, 1859, fig. 2,020; H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 327; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Melatoma pagoda Lea, Reeve, Monog. Melatoma, 1860, sp. 1.

Schizostoma Wetumpkaensis Lea, Proc. Acad. Nat. Sci., Phila., 1860, p. 187; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 251, pl. 35, fig. 56; Obs. Gen. Unio, IX, 1863, p. 73, pl. xxxv, fig. 56; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 169; Tryon, Monog. Strepom., 1873, p. 366; Lewis, Fauna of Ala., 1876, p. 23.

Melatoma Wetumpkaense Lea, Reeve, Monog. Melatoma, 1861, sp. 17.

Melatoma ornata Anth., MSS., Reeve, Monog. Melatoma, 1861, sp. 11.

Gyrotoma ornata Anth., Paetel, Cat., 1888, p. 362.

Melatoma Anthonyi Reeve, Monog. Melatoma, 1861, sp. 12.

Gyrotoma Anthonyi Reeve, Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Schizostoma Anthonyi Reeve, Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 368; Lewis, Fauna of Ala., 1876, p. 22.

Melatoma funiculatum Lea, Reeve, Monog. Melatoma, 1860, sp. 5.

Schizostoma pyramidatum Shutt., Hinkley, Nautilus, XVIII, 1904, p. 41.

Gyrotoma lacta incisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 182.

Description: Shell carinate, conical, rather thick, dark horn-color; spire rather short; sutures very much impressed; whorls six; fissure small; aperture elliptical, within whitish; columella smooth.

Habitat: Tuscaloosa, Alabama.

Diameter, .35; length, .75 of an inch.—Lea.

The pagoda-like form of this species is especially striking in the juvenile specimens and to such an extent, indeed, that these shells resemble *Goniobasis catenaria* Say. The carinae are very wide and turned upward at the edges. The suture is deeply channelled, the fissure a mere indentation. Embryo shells are about 1 1-4 to 2 whorls in size, unsculptured. The first two carinated whorls are scalloped by strong and regularly spaced plicae. As the animal grows larger, the carinae tend to disappear so that in many instances the shell is ventricose and smooth. The Wetumpka form is characterized by revolving folds, these disappearing in up-river specimens. Microscopical sculpture typically gyrotomoid.

Color varies from Ridgway's "old gold" to warm sepia. The proportion of banded to unbanded shells is about five to four. The prevailing banding system is four equidistant bands of the same width. The columella is rather narrow, rounded, with a slight nodulous thickening above. The outer lip is sharp-edged, slightly sinuous. A Wetumpka specimen measured 20 x 12 1-2 mm., the largest from up-river shoals, 22 1-2 x 14 mm.

The fissure is short, straight and bluntly rounded at the opening in old shells. It is seldom more than 3 mm. in depth. Compared with the fissure in *pumilum* that of *pagoda* is shorter and more flaring; apparently it is always straight.

The known range for the species is from The Bar, Chilton County, to Wetumpka, Elmore County.

Lea speaks of *wetumpkaensis* as umbilicate. This is merely an effect of erosion. Sometimes the animal leaves a chink close to the border of the columella and the opening is widened irregularly by corrosion. Three lots of *wetumpkaensis* in the Lea collection agree very well with *pagoda,* though less carinated and having color bands. *Ornata* is a young shell. The locality given, North Carolina, is apparently, as Tryon points out, a confusion with *Anculosa ornata* Anth. from that state. Dr. Walker examined the type of *anthonyi* in the British Museum and found it to be identical with *pagoda.* Lewis (5, p. 23) suggested the possibility of *wetumpkaensis* being a variety or the young of *pagoda.*

Gyrotoma pumilum (Lea)

Pl. I, figs. 10 and 11

Schizostoma pumila Lea, Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 187; Journ. Acad. Nat. Sci., V, n. s., 1862, p. 252, pl. 35, fig. 57; Obs. Gen. Unio, IX, 1863, p. 74, pl. xxxv, fig. 57; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 169; Tryon, Monog. Strepom., 1873, p. 357; Lewis, Fauna of Ala., 1876, p. 23.

Gyrotoma pumila Lea, Binney, Check List, 1860, No. 328; Brot, List, 1862, p. 27.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 182.

Melatoma Alabamense Lea, Reeve, Monog. Melatoma, 1861, sp. 20.

Schizostoma globosa Lea, Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 186; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 252, pl. 35, fig. 58; Obs. Gen. Unio, IX, 1863, p. 74, pl. xxxv, fig. 58; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168.

Schizostoma excisum Lea, Hinckley, Nautilus, XVIII, 1904, p. 41.

Gyrotoma globosa Lea, Binney, Check List, 1860, No. 321; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Melatoma globosum Lea, Reeve, Monog. Melatoma, 1861, sp. 18.

Description: Shell striate, top-shaped; rather thin, pale horn-color, imperforate; spire very obtuse; sutures much impressed; whorls six, ventricose, the last very large; fissure straight and rather short; aperture rather small, ovate, white within, angular at the base and somewhat canaliculate; columella white, twisted and thickened below; outer lip acute and sinuous.

Habitat: Alabama; B. W. Budd, M. D.

Diameter, .40; length, .63 of an inch.—Lea.

The fissure of *pumilum* is "rather short" only as compared with the character in such species as *excisum.* It may be considered as moderately deep for the genus. It is narrow, usually straight, rarely slightly oblique. In Wetumpka specimens examined, this slit has a maximum depth of 7 1-2 mm., in a specimen from Higgin's Ferry, it is 9 1-4 mm. deep. The girdle is more marked in some specimens than in others, varying also in color and size. Cross sections showed the girdle to be hollow for about 3 or 4 mm. behind the fissure. Behind this hollow space it was filled with fine crystalline shell material.

The adult is ovate, with whorls slightly convex, the base rounded; often very heavy. The spire in partly grown shells is obtuse, with faint plicae, often missing. The largest Wetumpka specimen measures 18¼ x 11½ mm., the largest up-river shell, 22 x 12 mm. Ten or twelve revolving folds appear on the body whorl in Wetumpka lots, tending to disappear in colonies

farther up the Coosa. For example, at Butting Ram Shoals, half the *pumilum* are smooth. Color varies from sulphine-yellow to dark olive. About one shell in four lacks color bands. The prevailing formula is four bands, the third from the top being smaller than the others. The aperture is ovate to elliptical, white to yellowish-white. In Wetumpka shells the folds show through as broad white bands in the aperture. The columella is rounded, not wide, white to bluish-white. It is not nearly as stout as might be expected in a shell of this size. At the mouth of the fissure is a spot of white callus. The outer lip is curved outward at the top and is slightly crenulate in shells with folds.

In juveniles the spire is smooth, conic, the whorls flat, the suture not much impressed, the periphery angular. The fissure begins with the fifth whorl. Embryo shells are of about 1½ whorls, closely coiled and without sculpture.

The species occurs from Weduska Shoals to Wetumpka. The Weduska Shoals specimens are a dwarf form, occurring in very small numbers. The largest is 19 x 9 mm. The shell is delicate, shining, the upper whorls having low plicae, the base bearing obscure folds. The fissure in these specimens is straight to slightly oblique, 3 to 4 mm. in depth. The temptation has been to allow them a distinctive name, but the form appears to correspond with dwarf *pumilum* collected by Mr. Smith at Higgin's Ferry, The Bar and Duncan's Riffle.

A note upon one of Mr. Smith's labels for this species reads, "On rocks, in very swift water, 1-3 feet deep."

Hinkley (2, p. 41) makes *pumilum* a synonym of *excisum*. An examination of the types of the two species compels me to disagree with him.

Gyrotoma alabamensis (Lea)

Pl. I, figs. 12 and 13

Schizostoma Alabamensis Lea, Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 187; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 250, pl. 35, fig. 54; Obs. Gen. Union, IX, 1863, p. 72, pl. xxxv, fig. 54; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 367; Lewis, Fauna of Ala., 1876, p. 22.

Gyrotoma Alabamensis Lea, Binney, Check List, 1860, No. 305; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 181.

Melatoma babylonicum Lea, Reeve, Monog. Melatoma, 1860, sp. 6.

Description: Shell striate, elliptical, stout, yellowish-olive, imperforate; spire obtusely conical; sutures very much impressed; whorls six, banded, rather inflated, the last very large; fissure oblique and rather short; aperture rather large, ovate, banded within and obtusely angular at the base; columella white, somewhat thickened above and below; outer lip sharp and sinuate.

Habitat: Alabama; B. W. Budd, M.D., and Dr. E. R. Showalter.

Diameter, .50; length, .90 of an inch.—Lea.

The description, "fissure oblique and rather short" so misled Mr. Smith that when he found *alabamensis* he was compelled to believe that he had come upon a new species. Examination of the type disclosed, however, that the shells of Lea and Smith were the same. The fissure varies from straight to oblique. Of 37 shells from The Bar, Chilton County, 16 had

straight fissures. The difference did not seem to be a matter of age. The depth of fissure is from 6 mm. in half-grown shells to 10 mm. in old. The girdle is yellow, rather wide, and is well-marked in nearly all specimens.

The species is probably the most robust of the genus. The largest specimen in the Alabama collection measures 26½ x 13½ mm. The base is sub-angular up to three-fourths of the growth. In adults, it is rounded. The folds are low, not always regularly-spaced, and are stoutest in young shells. Occasional smooth shells have been taken. A distinct tendency toward plication is noticeable upon the upper whorls. The nearly miscroscopic sculpture consists of fine growth lines, crossed by discontinuous, wavy transverse lines. The color is buckthorn-brown to deep olive. Two bands of equal width, at top and base respectively, and a third band, much wider, at the periphery constitute the commonest banding formula. In many specimens coloring matter is deposited in the base of the folds and this shows in the aperture as bands or lines. The aperture is elliptical rather than ovate. The columella is white, not very wide, thinning above the center into a bluish-white wash with a porcelainous node at the mouth of the fissure. The sinus is distinct. The outer lip is sharp-edged, crenulate, slightly sinuous.

Young shells are ovate, sub-angulated, plicate upon the post-embryo whorls; the fissure straight, not wide; the columella narrow, yellowish-white; the sinus having a shallow channel. Seven or eight whorls are indicated for the adult specimen.

The range of *alabamensis* is from Peckerwood Shoals, Talladega County, to Duncan's Riffle, Chilton County.

Peckerwood Shoals shells are wider in proportion to height than specimens from other known localities and they show, more than these others, the relationship of *alabamensis* and *cariniferum* Anth. A varietal name does not seem to be warranted in the case of this race unless other varieties, and there are several, are also so baptized. In nearly all the lots are shells close to *pumilum* in general appearance. *Pagoda* may be considered a third or fourth cousin to the southward and *cariniferum* a first or second cousin to the north.

Gyrotoma cariniferum Anthony

Pl. I, figs. 14 and 15

Gyrotoma carinifera Anth., Proc. Acad. Nat. Sci., Phila., XII, Feb. 1860, p. 66; Binney, Check List, 1860, No. 310; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Melatoma cariniferum Anth., Reeve, Monog. Melatoma, 1861, sp. 13.

Schizostoma cariniferum Anth., Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 353; Lewis, Fauna of Ala., 1876, p. 22.

Schizochilus Showalterii Lea, Proc. Acad. Nat. Sci., Phila., XII, March, 1860, p. 93.

Schizostoma Showalterii Lea, Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 246, pl. 35, fig. 49; Obs. Gen. Unio, IX, 1863, p. 68, pl. xxxv, fig. 49.

Gyrotoma Showalterii Lea, Binney, Check List, 1860, No. 334; Brot, List, 1862, p. 28.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 181.

Description: Shell conic, thick, dark brown; spire obtusely elevated, truncate, though not abruptly so, six whorls remaining, one or two having apparently been lost by truncation; carinations elevated, subacute and found on all the whorls, two on each of the spiral ones and three or four on the body whorl; fissure direct, broad and moderately deep, extending about one-fifth around the shell; sutures irregular, much modified by the carinae, and often concealed in part by them; aperture ovate and banded within; columella much rounded, callous at the lower part only; outer lip irregularly waved, its outline modified by the carinae on the body-whorl; no sinus.

Habitat: Coosa River, Alabama.

Length of shell, 7-8; breadth of shell, 1-2 of an inch. Length of aperture, 5½-16 of an inch; breadth of aperture, 1-4 of an inch.—Lea.

The opportunity has been given to examine the type of *cariniferum,* which is in the Museum of Comparative Zoology. The shell is about three-fourths grown. The fissure is rather narrow as compared with the same character in several other species, is slanting and 8½ mm. deep. In twenty-five other specimens the fissure of seven is straight, very slightly oblique in one and noticeably oblique in seventeen. The girdle is narrow and of much the same color as the body of the shell.

Full grown specimens are not so stoutly ribbed as younger ones, and in instances the folds become almost obsolete. A few greatly resemble *G. alabamensis* Lea. The largest shell measured 24 x 15 mm. It should be said that in the cut published by Tryon (10, p. 353) the ribs are made to seem more twisted than they actually are in the type. The color is brownish olive. The banding formula, common to the group, is four bands, the third from the top being smaller than the rest. Variations occur, but they are modifications of this formula. The aperture is more often elliptical than ovate. In old specimens the columella is white, wide, continuous and with the usual node of porcelain-like callus at the top. Young shells are angulated at the base. They indicate that an uneroded adult would have eight whorls.

The only locality known for this species is Fort William Shoals. In 1914, shortly after a visit to this site, Mr. Smith wrote to Dr. Walker, "On a reef * * * I struck *G. cariniferum;* the only ones I had seen before were a broken specimen in the Schowalter collection and about ten I had collected last year in a lower part of Fort William Shoals. In this new place we gathered about 200 in three hours, and I think we scraped the place nearly clean. The species occurred only in about fifteen yards of the reef and always in the swiftest water where other Gyrotoma cannot stick. There was one little pool under a fall which must have yielded over 100 fine ones."

Hinkley (2, p. 41) mentions *showalterii* Lea. It is not clear that he refers to the species which has had to give way to *cariniferum* by reason of the rule of priority or to the one given the same name by Lea in 1864.

GROUP OF *Gyrotoma lewisii*

Elongate to ventricose, the whorls almost flat, sometimes ligulate, the shell rather heavy and resembling *Goniobasis impressa* Lea in sculpture; fissure oblique, with a maximum depth of 6 mm.; girdle not pronounced; aperture narrow; the sinus distinct; bands consisting usually of many fine lines.

Gyrotoma lewisii (Lea)

Pl. I, figs. 16, 17, and 18

Schizostoma Lewisii Lea, Proc. Acad. Nat. Sci., Phila., XXI, 1869, p. 62; Journ. Acad. Nat. Sci., Phila., VIII, 1874, p. 61, pl. 21, fig. 16; Obs. Gen. Unio, XIII, 1874, p. 65, pl. xxi, fig. 16; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Lewis, Fauna of Ala., 1876, p. 23; Hinkley, Nautilus, XVIII, 1904, p. 41.

Description: Shell closely striate, subcylindrical, rather thin, yellowish-brown, imperforate; spire conical, folded; sutures very much impressed; whorls about seven, the last one large; fissure oblique and short; aperture large, rhomboidal, banded within; outer lip crenulate and sinuous; columella white, thickened and twisted.

Habitat: Coosa River, Alabama, Dr. E. R. Schowalter.

Diameter, .5; length, .9 inch.—Lea.

The fissure is oblique, shallow, 2¾ to 3¾ mm. in depth. There is no distinct girdle. A broadening or shouldering of the whorl immediately below the suture appears to serve the purpose of covering the fissure as growth proceeds. In young shells this shoulder does not occur though the mollusk has a well-developed fissure at this stage.

Lewisii is stout, ventricose to elongate and is covered with fine, sharply cut folds or riblets, closely set and varying slightly in size. Growth lines are fine, being crossed by minute discontinuous revolving lines not always distinct beneath a hand lens. A few specimens are constricted upon the body whorl though none taken by Mr. Smith is so much constricted as in the figure of Lea's type. Color usually citrine. All the ribs seem to contain more or less coloring matter. In young shells this shows through into the aperture, giving an effect of numerous bands. As shell material is deposited the finer bands or lines tend to disappear. The usually narrow and elliptical aperture has a distinct sinus at its base. The columella is broad and, in immature specimens, merely a wash of white above the center of the aperture. The node at the top is not prominent. One specimen has a reddish columella. The largest shell is 22½ x 12½ mm.

Half-grown specimens are conic, subangulate, slightly carinate and have a pronounced sinus. The fissure is very shallow, but well-marked.

Mr. Smith's shells, and presumably those taken by Dr. Schowalter, were collected on Fort William Shoals. Hinkley (2, p. 41) gives Wilsonville as another locality. This would seem to be on or within touch of Three-Island Shoals.

Dr. Lea remarked upon the resemblance of his species to *Goniobasis impressa* Lea. Save in regard to the fissure of *lewisii*, the two shells are exceedingly alike. The one, I believe, can be considered an offshoot of the other.

Gyrotoma hendersoni H. H. Smith, new species

Pl. II, figs. 19, 20, and 21

Shell: Subcylindrical, rather heavy, whorls almost flat, the last broadly rounded at the base. Apex eroded, only two whorls remaining. The entire shell is covered with low folds of varying size which tend to wave or break where new shell material has been deposited after rest periods. Between the folds of the penultimate whorl the fine

vertical growth lines are crossed by transverse lines, very delicate and usually discontinuous. Fissure oblique, 6 mm. in depth. The suture is covered by a narrow, cord-like, irregular girdle somewhat lighter than the general body color. In a broken place in this "hem" the suture appears as deeply impressed or channelled. Color of shell brownish-olive. The bands are deposits of coloring matter in the base of the folds, sometimes coalescing so that for the eleven folds of the body whorl six bands show in the aperture. Columella narrow, rounded from center to base, flattened above the center and having a heavy callus at the fissure; white from center to base, dull purple above. Aperture elliptical, with a distinct sinus below. Outer lip a little crenulate, firm, broadly curving outward at the top and slightly inward at the base.

Operculum: Leaf-like, leathery, very dark red. Apex acute, base rounded; right margin much more curved than the left. Whorls three, the first two tightly coiled and close to the left margin and about 1 mm. from the base. The region of the inner whorls is excavated or crater-like. Radiating lines are of varying strength. Altitude 8 1-2 mm.; diameter 4 1-2 mm.

Measurements: Altitude, 21 mm.; diameter, 12 mm. Aperture: Lowest part of fissure to base, 10 1-2 mm.; diameter, 4 1-4 mm.

Type Locality: Coosa River, Fort William Shoals, Talladega County, Ala.

Type in Museum of Zoology, University of Michigan; paratypes in Alabama Museum of Natural History.

The affinities of this species are with *G. lewisii* (Lea). It differs in having fewer and stouter folds, a more rounded body whorl, a deeper and less oblique fissure and less shouldered aspect. While the question may rise as to whether *lewisii* is *Goniobasis impressa* Lea with a gyrotomoid outer lip the position of *hendersoni* as a true Gyrotoma is not to be questioned.

The fissure varies from 3½mm. in depth in young shells to 6 mm. in adults. As depth increases, the fissure becomes less oblique, or to put it another way, more narrow. There is little variation in form, sculpture and color. The bands are from five to ten, following no formula as in most other species of the genus. A young specimen of *hendersoni* is thin, subangulate. The fissure is shallow, the suture rather indistinct, the bands many and linear. Eight whorls are indicated for a full-grown specimen.

The only locality known for this species is Fort William Shoals. Writing from this place on July 17, 1914, Mr. Smith said: "On a reef just above we got the regularly striate form which I have been callng *G. lewisii*, though I am not at all sure. With it another which I take to be *G. babylonicum*, and a third form undescribed which I propose to name *G. hendersoni;* it is striate much like *lewisii*, but has a square and moderately deep slit." In September of the same year, Mr. Smith wrote: "The species which I propose to name *hendersoni* is one of the most beautiful of the genus and is apparently very constant."

GROUP OF *Gyrotoma excisum*

Quadrate, bulbous, conic or elongate; the whorls smooth or with folds, often faintly plicate; fissure ordinarily straight and as deep as 10 mm.; girdle well-marked, though sometimes absent; aperture elliptical; sinus distinct; bands: three in *excisum*, four in *lacinatum*.

Gyrotoma excisum (Lea)

Pl. II, figs. 22 and 23

Melania excisa Lea, Proc Amer. Phil. Soc., II, 1843, p. 242; Trans. Amer. Phil. Soc., IX, 1844, pp. 25, 29; Trans. Amer. Phil. Soc., X, 1848, p. 93; Obs. Gen. Unio, IV, 1848, pp. 25, 29, 93; Jay, Cat., 4th ed., 1852, p. 273.

Schizostoma excisa Lea, Wheatley, Cat. Shells U. S., 1845, p. 28; Lea, Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 250; Obs. Gen. Unio, IX, 1863, p. 72; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, pp. xv, xxiii, xxv, 356; Lewis, Fauna of Ala., 1876, p. 23.

Gyrotoma excisa Lea, H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 317; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol, Soc., X, 1912, p. 181.

Melatoma excisum Lea, Reeve, Monog. Melatoma, 1860, sp. 2.

Melatoma Showalterii Lea (prob. *excisum*), Reeve, Monog. Melatoma, 1861, sp. 23.

Gyrotoma ovoideum Shutt., Mittheil, Bern. Nat. Gesell., No. 50, July 22, 1845, p. 88; H. & A. Adams, Genera, I, 1858, p. 305, pl. 32, fig. 4; Paetel, Cat., 1888, p. 362.

Schizostoma ovoideum Shutt., Tryon, Monog. Strepom., 1873, pp. xv, 356; Lewis, Fauna of Ala., 1876, p. 23; Hinkley, Nautilus, XVIII, 1904, p. 41.

Gyrotoma bulbose Anth., Proc. Acad. Nat. Sci., Phila., Feb. 1860, p. 65; Binney, Check List, 1860, No. 309; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Melatoma bulbosum Anth., Reeve, Monog. Melatoma, 1861, sp. 22.

Schizostoma bulbosum Anth., Lewis, Amer. Jour. Conchol., 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 361; Lewis, Fauna of Ala., 1876, p. 22.

Gyrotoma ovalis Anth., Proc. Acad. Nat. Sci., Phila., Feb., 1860, p. 65; Binney, Check List, 1860, No. 325; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Schizostoma glans Lea, Proc. Acad. Nat Sci., Phila., 1860, p. 186; Journ, Acad. Nat. Sci., Phila., V, n. s., 1862, p. 248, pl. 35, fig. 52; Obs. Gen. Unio, IX, 1863, pp. 70, 71, 74, pl. xxxv, fig. 52; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 363; Lewis, Fauna of Ala., 1876, p. 23; Hinkley, Nautilus, XVIII, 1904, p. 40.

Gyrotoma glans Lea, Binney, Check List, 1860, No. 320; Brot, List, 1862, p. 27.

Melatoma ellipticum Anth., MSS., Reeve, Monog. Melatoma, 1861, sp. 21.

Gyrotoma ellipticum Anth., Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Schizostoma ellipticum Anth., Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 359; Lewis, Fauna of Ala., 1876, p. 23; Hinkley, Nautilus, XVIII, 1904, p. 40.

Description: Shell striate, subfusiform, rather thick, yellowish; spire ovately conical; sutures impressed; whorls flattened; aperture cut out above, small, elliptical, white.

Habitat: Alabama.

Diameter, .40; length, .64 of an inch.—Lea.

As variation goes in Gyrotoma this species is remarkably wanting in variability. At Wetumpka it bears folds in common with many other Pleuroceridae there and at Three-Island Shoals, the other extreme of its occurrence, it is ordinarily lighter in color and smooth. Otherwise there is little difference between the members of the two colonies. This may argue that *excisum* is the oldest of the genus, time having brought its usual uniformity, and this hypothesis is supported by the fact that the species has the longest range of all Gyrotomae.

The fissure is deep, up to 10 mm., in the largest adults, very narrow in the young and widening with age; ordinarily straight, but in a few shells

waving upon the lower edge. The girdle is thread-like to rounded and thick, and of slightly lighter color than the body of the shell.

Forms are quadrate, bulbous, ovate, elongate, any one colony having specimens of these shapes. Where folds occur they are low, not very conspicuous. Of 38 specimens in one lot taken at The Bar, 29 are obscurely plicate upon the upper whorls, 9 are without plicae. This ratio of sculptured shells to those lacking plicae is about the same wherever the species occurs. In general the shell is of a soft silky appearance. Color is aniline-yellow to mummy-brown. The commonest banding formula is three bands, the one at the periphery being wider than the others. The columella in the oldest specimens is heavy, broad, complete to the top and thickened at the fissure. Color is usually white, but at times yellowish-white, pink or purple. The sinus is distinct, pointed. The outer lip is slightly sinuous. Mr. Smith's largest *excisum* measured 23 x 12 mm.

The embryo is smooth, tightly coiled. Shells developed to the fifth whorl are smooth with a slight carina at the periphery; the sinus being well marked; the fissure straight, tight and about 3 mm. in depth. Partly grown individuals are not so angular at the base as in most other species. The whorls indicated for an adult are seven or eight.

Shuttleworth's shells from the Coosa River were sent to him by Rugel and this collector took *pyramidatum* not far from the northernmost known locality for *excisum*. It seems probable that the shell to which Shuttleworth gave the name *ovoideum* came from this point or very close to it. *G. ellipticum* Anth. in the Philadelphia Academy, received from Anthony himself, is the same as his *bulbosum* except that it is elongate. *Bulbosum* is *excisum* in its old age, *ovalis* in its graceful youth. The tuberculation of *glans*, cited by Tryon as if a distinguishing character, occurs rarely and seems to be without significance.

Gyrotoma laciniatum (Lea)

Pl. II, figs. 24 and 25

Schizostoma laciniatum Lea, Proc. Amer. Phil. Soc., IV, 1845, p. 167; Trans. Amer. Phil. Soc., X, 1848, p. 95, pl. ix, fig. 57; Obs. Gen. Unio, IV, 1848, p. 95, pl. ix, fig. 57; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 253; Obs. Gen. Unio, IX, 1863, p. 75; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, pp. xv, 359; Lewis, Fauna of Ala., 1876, p. 23.

Gyrotoma laciniata Lea, H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 324; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Schizostoma castanea Lea, Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 186; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 247, pl. 35, fig. 50; Obs. Gen. Unio, IX, 1863, p. 69, pl. xxxv, fig. 50; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 355; Lewis, Fauna of Ala., 1876, p. 22; Hinkley, Nautilus, XVIII, 1904, p. 40.

Gyrotoma castanea Lea, Binney, Check List, 1860, No. 311; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 181.

Description: Shell smooth, obtusely conical, rather thick, banded, yellowish horn-color; spire obtuse; sutures excavated; whorls convex; fissure deep; aperture elliptical, whitish within; columella smooth, thickened above.

Habitat: Tuscaloosa, Alabama.

Diameter, .25; length, .45 of an inch.—Lea.

This is the smallest species of the genus. The largest shell examined measures 16 x 10 mm. The average size of fourteen specimens is 14.9 x 8.5 mm. The species resembles *excisum* Lea in sculpture, fissure and banding system. It occurs from Fort William Shoals, Talladega County, to Wetumpka, Elmore County. A note by Mr. Smith with *laciniatum* from Fort William Shoals reads, "Found in a few places along the eastern or Talladega County side and quite close to the banks where the water is swift; on or clinging to the lower side of stones. In one place, partly under overhanging bushes, we collected over 100 within a few yards, but generally the species is rare."

In *laciniatum* the fissure is very deep in porportion to the shell; it is narrow and hugs the body whorl. Its depth in adults is 7 to 7½ mm. The girdle is small and thin. Of 48 specimens the girdle is absent in 13.

The shell is conic, subangulated, with whorls flat to slightly convex. Upper whorls are smooth to carinate, showing a tendency to form a few obscure plicae. Commonly there are four or five low folds upon the base, seldom very distinct. Beneath the fissure are low vertical puckerings, made conspicuous by spots of coloring matter between them. Growth lines are fine, irregular, crossed on parts of the shell by revolving lines which in few instances go clear around the whorl. Color is buckthorn-brown to clove-brown. The prevailing banding formula is four bands of equal width, the two in the center approximate. These latter bands sometimes coalesce into the formula ordinarily occurring in *excisum*. The aperture is elliptical, nearly pointed at the top, more rounded at the base and having a slight sinus. The columella is small, regularly rounded, white and having a node at the fissure. In only one specimen observed was the columella developed fully above the center. The outer lip is sinuous, more angular at the top than rounded.

The embryo shell is very small, smooth, tightly coiled. Some juveniles are strongly carinate, others smooth. Irregular plicae occur. There are three bands, that at the center dividing into two. In shells of five whorls the fissure is quite deep. The adult *laciniatum* has seven or eight whorls.

A comparison of the types of *laciniatum* and *castaneum* proved them to be identical. Lea's first specimens were apparently from Wetumpka. It was not until about fifteen years later that he saw the up-river forms.

GROUP OF *Gyrotoma incisum*

Cylindrical to globose; whorls shouldered, often constricted, sometimes nodulous; smooth to striate; fissure usually shallow and oblique though in *amplum* as deep as 9 mm. and in instances straight; girdle stout and irregular when present; aperture ovate; sinus more noticeable in young than in adult shells; bands three.

Gyrotoma incisum (Lea)

Pl. II, figs. 26, 27, 28, and 29

Anculosa incisa Lea, Proc. Amer. Phil. Soc., II, 1843, p. 243; Trans. Amer. Phil. Soc., IX, 1844, p. 28.

Schizostoma incisa Lea, Wheatley, Cat. Shells U. S., 1845, p. 28; Lea, Trans. Amer. Phil. Soc., X, 1848, p. 93; Lea, Obs. Gen. Unio, IV, 1848, pp. 28, 93; Lea, Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 186; Hanley, Conchol. Misc., Melania, 1854-58, pl. 5, figs. 44, 45; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, pp. xxiii, xxv, 378; Lewis, Fauna of Ala., 1876, p. 23; Hinkley, Nautilus, XVIII, 1904, pp. 40, 41.

Melania incisa Lea, Jay, Cat., 4th ed., 1852, p. 274.

Leptoxis incisa Lea, Haldeman, in Chenu's Illustrations Conchyliog., 1843-53, liv. 73, p. 2, pl. 1, figs. 24-26; Binney, Check List, 1860, No. 363.

Gyrotoma incisa Lea, H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 323; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362; Goodrich, Anculosae Ala. Drain., 1922, p. 56.

Gyrotoma laeta incisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 182.

Melatoma incisum Lea, Reeve, Monog. Melatoma, 1860, sp. 4.

Schizostoma curta Mighels, Bost. Proc., I, Oct. 1844, p. 189; Tryon, Monog. Strepom., 1873, pp. xv, 363; Lewis, Fauna of Ala., 1876, p. 22.

Gyrotoma curta Migh., H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 314.

Gyrotoma curta Gould, Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 181.

Schizostoma Buddii Lea, Proc. Amer. Phil. Soc., IV, 1845, p. 167; Trans. Amer. Phil. Soc., X, 1848, p. 94, pl. ix, fig. 53; Obs. Gen. Unio, IV, 1848, p. 94, pl. ix, fig. 53; Obs. Gen. Unio, IX, 1863, p. 74; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, pp. xv, 370; Lewis, Fauna of Ala., 1876, p. 22.

Gyrotoma Buddii Lea, H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 308; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Schizostoma constrictum Lea, Proc. Amer. Phil. Soc., IV, 1845, p. 167; Trans. Amer. Phil. Soc., X, 1848, p. 94, pl. ix, fig. 55; Obs. Gen. Unio, IV, 1848, p. 94, pl. ix, fig. 55; Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 186; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 246; Obs. Gen. Unio, IX, 1863, p. 68; Journ. Acad. Nat. Sci., Phila., VI, 1866, p. 149; Obs. Gen. Unio, XI, 1867, p. 105; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, pp. xv, 373, 374; Lewis, Fauna of Ala., 1876, p. 22.

Gyrotoma constricta Lea, H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 302; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Schizostoma funiculatum Lea, Proc. Amer. Phil. Soc., IV, 1845, p. 167; Trans. Amer. Phil. Soc., X, 1848, p. 95, pl. ix, fig. 56; Obs. Gen. Unio, IV, 1848, p. 95, pl. ix, fig. 56; Tryon, Monog. Strepom., 1873, pp. xv, 371.

Gyrotoma funiculata Lea, H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 318; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Gyrotoma quadrata Anthony, Proc. Acad. Nat. Sci., Phila., XII, Feb. 1860, p. 65; Binney, Check List, 1860, No. 330; Paetel, Cat., 1888, p. 362.

Melatoma quadratum Anth., Reeve, Monog. Melatoma, 1860, sp. 7.

Schizostoma virens Lea, Proc. Acad. Nat. Sci., Phila., XII, 1860, p. 187; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 253, pl. 35, fig. 59; Obs. Gen. Unio, IX, 1863, p. 75; pl. xxv, fig. 59.

Gyrotoma virens Lea, Binney, Check List, 1860, No. 335; Brot, List, 1862, p. 28; Paetel, Cat., 1888, p. 362.

Gyrotoma obliqua Anth., MSS., Tryon, Monog. Strepom., 1873, p. 378; Paetel, Cat., 1888, p. 362.

Description: Shell smooth, ovately gibbous, thick, yellowish-brown; spire short; whorls four, flattened; columella thickened above; aperture large, ovate, white.

Habitat: Alabama.

Diameter, .44; length, .64 of an inch.—Lea.

In *incisum* the fissure is shallow and oblique. It is as deep as 7½ mm. in specimens from Weduska Shoals. It is most shallow in specimens from Butting Ram Shoals down to Wetumpka, not exceeding 2¾ mm. in depth. The girdle, which represents the material filling the fissure as growth proceeds, is usually well-marked when it is noticeable at all, particularly toward the end of growth of adult individuals.

The shell is heavy, broadly rounded at the shoulder, frequently with a broad constriction around the center of the whorl. Hinkley (2, p. 40) speaks of *incisum* as never nodulous. Occasional specimens do have nodes at the shoulder, but these markings appear to be without significance. The largest shell observed measures 22 x 14½ mm. The growth lines are usually fine and regular and these are often crossed by discontinuous transverse lines, plainest at the top of the whorl. Of 78 shells from one lot from Wetumpka, 11 showed revolving folds of more or less prominence. The folds are seldom present in *incisum* coming from farther up the river. Color varies from olive-ocher to cinnamon-brown. Bands occur much more commonly than not. Of 77 banded shells from Wetumpka, 74 had a band at the top of the whorl, one at the periphery and a third at the base. This is the prevailing banding formula in the species from other localities. The aperture is ovate, varying slightly. The columella in adults is white, rather wide, broadly rounded and regularly curved vertically, being thickened into a small node at the mouth of the fissure. The outer lip is sharp-edged, sinuous.

Juveniles are conic, angulated at the base, having the whorls flat and without carinae. A channelled sinus, present in all the young examined, is much more pronounced than in the case of adults. The fissure begins with the third whorl and is easily distinguished in the fourth. Six or seven whorls for the fully-grown shell are indicated.

The range of *incisum* is from Weduska Shoals, Shelby County, to Wetumpka, Elmore County.

Lea's type is a narrow, somewhat constricted form of the Wetumpka aspect. His *virens* is a young shell. *Curta* Mighels appears to me to be readily recognizable from the description. I examined the type of *buddii* Lea, the locality for which is given in error as Tuscaloosa, but felt uncertain about the identification. Mr. W. B. Marshall of the National Museum kindly furnished me later with an excellent photograph and I can say with confidence that the shell is the same as *incisum*. The cut in Tryon (6, p. 371) could not have been made from the type. The constriction in *constrictum* is fairly common to the species. *Funiculatum* Lea is a deformed mollusk.

At the mouth of the Yellowleaf Creek of Chilton County, Mr. T. H. Aldrich took numbers of a small form of Gyrotoma which, though suggestive of *walkeri* because of its delicacy, I assign to *incisum* on account of the deeper fissure. These shells have a kind of family resemblance to *Anculosa aldrichi* H. H. Smith, taken at the same locality. This Anculosa also is

dwarfed. Larger Gyrotomae and larger Anculosae have been collected in the same place. The student is led to wonder whether these dwarfed shells do not dwell in some particular spot on these shoals where the conditions of food supply, current, temperature or some other cause tend to stunt molluscan growth as sometimes in very cold springs shell life is at once small and plainly of mature development.

Gyrotoma walkeri H. H. Smith, new species

Pl. II, figs. 30, 31, and 32

Shell: Cylindrical, shouldered, solid; body whorl slightly constricted, apex eroded, base rounded and with only a suggestion of a sinus. Growth lines very fine, crossed by delicate, waving lines to be seen on all parts of the exterior except where it is worn smooth. Rest period scars rather rough, forming a few irregularly spaced nodules. Fissure very shallow, very oblique, 2 mm. deep at the suture. There is no girdle. Suture impressed, irregular. Color buckthorn-brown. Bands three, one ending at lower edge of fissure, one at periphery and one at the base. Aperture ovate, yellowish-white within. Columella white, broadly-rounded, having a heavy deposit of its material at the fissure. Outer lip firm, sharp-edged, forming a sinuous line with the fissure.

Operculum: Ovate, thick, dark reddish-brown, measuring 3 1-2 mm. diameter by 5 1-2 mm. altitude. The left margin is thickened, smooth-edged; right margin broadly curved, broken and worn; basal margin rounded, eroded close to the polar point. Whorls three, the first two regularly and tightly coiled. Growth lines fine to coarse.

Measurements: Altitude, 15 mm.; diameter, 10 mm. Aperture, base to suture, 10 1-2 mm.; base to lowest point of fissure, 6 mm.; diameter 4 1-4 mm.

Type Locality: Coosa River, Cedar Island, Chilton County, Alabama.

Type in Museum of Zoology, University of Michigan; paratypes in Alabama Museum of Natural History.

This species appears to be a derivative of *G. incisum* Lea which has developed fixed, uniform specific characteristics. It is small for the genus and varies much more in the size of mature specimens than in form. The largest shell measures 17 x 11 mm. It is from Weduska Shoals. No folds appear upon any of the material. Growth lines are usually fine, but sometimes coarse and roughened near the shoulder. The waving transverse lines are strikingly beautiful in a few specimens which have not suffered a great amount of wear.

The fissure varies slightly in depth, but in none is it deeper than 3½ mm. It is frequently only a sinuous indentation. The girdle is absent in all the specimens examined.

Color is sometimes as dark as burnt-umber. Of 65 shells, 51 have bands, the formula in all being exactly that of the type.

Very young shells are smooth, lacking carinæ, plicæ and all other sculpture except microscopic growth lines. The base is obtusely angulate. The sinus is well-marked, slightly oblique. The fissure, about ½ mm. deep, begins with the fourth whorl and is hardly more than a sinuous, inturned part of the outer lip. Eight whorls are indicated for full-grown individuals.

The known localities for *walkeri* are Weduska Shoals, Shelby County; The Bar, Cedar Island, Higgin's Ferry and Duncan's Riffle, Chilton County; Butting Ram Shoals, Coosa County. One of Mr. Smith's labels carries the note, "swift water."

Gyrotoma amplum Anthony

Pl. II, figs. 33, 34, and 35

Gyrotoma ampla Anth., Proc. Acad. Nat. Sci., Phila., XII, Feb., 1860, p. 66; Binney, Check List, 1860, No. 306; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Melatoma amplum Anth., Reeve, Monog. Melatoma, 1861, sp. 16.

Schizostoma amplum Anth., Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 360; Lewis, Fauna of Ala., 1876, p. 22.

Gyrotoma recta Anth., Proc. Acad. Nat. Sci., Phila., XII, Feb., 1860, p. 64; Binney, Check List, 1860, No. 331; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Melatoma rectum Anth., Reeve, Monog. Melatoma, 1861, sp. 10.

Gyrotoma salebrosa Anth., Proc. Acad. Nat. Sci., Phila., XII, Feb., 1860, p. 66; Binney, Check List, 1860, No. 333; Paetel, Cat., 1888, p. 362.

Melatoma salebrosum Anth., Reeve, Monog. Melatoma, 1861, sp. 15.

Schizostoma salebrosum Anth., Lewis, Amer. Journ. Conchol., V, 1869-70, p. 169; Tryon, Monog. Strepom., 1873, p. 376; Lewis, Fauna of Ala., 1876, p. 23; Hinkley, Nautilus, XVIII, 1904, p. 40.

Gyrotoma robusta Anth., Proc. Acad. Nat. Sci., Phila., XII, Feb., 1860, p. 67; Binney, Check List, 1860, No. 332; Brot, List, 1862, p. 28; Paetel, Cat., 1888, p. 362.

Melatoma robustum Anth., Reeve, Monog. Melatoma, 1861, sp. 14.

Gyrotoma demissa Anth., Proc. Acad. Nat. Sci., Phila., XII, Feb., 1860, p. 64; Binney, Check List, 1860, No. 316; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Melatoma demissum Anth., Reeve, Monog. Melatoma, 1861, sp. 9.

Schizostoma demissum Anth., Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 372; Lewis, Fauna of Ala., 1876, p. 23.

Schizostoma glandula Lea, Proc. Acad. Nat. Sci., Phila., XII, May, 1860, p. 187; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 249, pl. 35, fig. 53; Obs. Gen. Unio, IX, 1863, p. 71, pl. 35, fig. 53; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 168; Tryon, Monog. Strepom., 1873, p. 377; Lewis, Fauna of Ala., 1876, p. 23.

Gyrotoma glandula Lea, Binney, Check List, 1860, No. 319; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Schizostoma Hartmanii Lea, Proc. Acad. Nat. Sci., Phila., XII, May, 1860, p. 187; Journ. Acad. Nat. Sci., Phila., V, n. s., p. 247, pl. 35, fig. 51; Obs. Gen. Unio, IX, 1863, p. 69, pl. 35, fig. 51.

Gyrotoma Hartmanii Lea, Binney, Check List, 1860, No. 322; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Melatoma nucula Anth., MSS., Reeve, Monog. Melatoma, 1861, sp. 19.

Gyrotoma nucula Anth., Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Schizostoma nuculum Anth., Lewis, Amer. Journ. Conchol., V, 1869-70, p. 169; Tryon, Monog. Strepom., 1873, p. 361; Lewis, Fauna of Ala., 1876, p. 23.

Schizostoma Showalterii Lea, (non Lea, 1860), Proc. Acad. Nat. Sci., Phila., XVI, 1864, p. 112; Journ. Acad. Nat. Sci., Phila., VI, 1866, p. 149, pl. 23, fig. 56; Obs. Gen. Unio, XI, 1867, p. 105; pl. 23, fig. 56.

Schizostoma Showalteriana "Lea", Tryon, Amer. Journ. Conchol., I, Oct., 1865, p. 335; Tryon, Monog. Strepom., 1873, p. 375; Lewis, Fauna of Ala., 1876, p. 23.

Schizostoma constrictum Lea, Hinkley, Nautilus, XVIII, 1904, p. 40.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 181.

Gyrotoma laeta incisa (Lea), Hannibal, Proc. Malacol. Soc., 1912, p. 182.

Description: Shell smooth, ovate, rather thick, olivaceous; spire not elevated, but acute; whorls 6-7, subconvex; sutures well defined; fissure broad, rather deep and waved; aperture moderate, elliptical, flesh-colored and banded within; columella

smooth, or slightly thickened only at the fissure; body-whorl striate and banded; whorls of the spire not banded, but having a thickened, cord-like line near the suture.

Habitat: Coosa River, Alabama.

Length, eleven-sixteenths; breadth, seven-sixteenths of an inch. Length of aperture, seven-sixteenths; breadth of aperture, four-sixteenths of an inch.—Anthony.

This species is close to the form of *incisum* which has a comparatively deep fissure, as at Weduska Shoals. But the young of that form have the typically shallow fissure. It is not so in the case of *amplum*. Moreover, the fissure in *amplum* is sometimes straight, never in *incisum*. Sometimes the lower edge of the fissure of *amplum* is waved, but this has not been observed in *incisum*. The depth of the slit in the species under consideration varies in adults from 6½ to 9 mm. The girdle is stout, often irregular.

In form the shell is somewhat cylindrical, noticeably shouldered and in instances slightly constricted though not so frequently or so deeply as in *incisum*. Ordinarily the mollusk is without revolving folds, but occasionally they do occur. Commonly the body whorl bears low nodules just below the suture. Growth lines are fine, often prominent and are crossed in places by waving transverse lines usually discontinuous. The largest specimen taken by Mr. Smith measures 23½ x 14½ mm. Color varies from olive-yellow to Mars-brown. The prevailing banding formula is three bands equidistant and of the same width. Bands in this species show a marked tendency to become obsolete. The columella is white to bluish-white, having a porcelainous node at the fissure and ending at the base in a distinct sinus.

Anthony erected several species at the same time from shells which seem to have come from Dr. Schowalter just after that collector's first visit to Fort William Shoals. Their novelty led to the placing of undue emphasis upon characters of no great significance. Thus *recta* was made a species principally upon the form of the shell and the absence of bands. The accentuation of rest scars was the justification of *salebrosa*. *Robusta* was differentiated from *salebrosa* by reason of its smoothness. *Demissa*, a single specimen, appears to have been one of the not very common adults of the genus which have a fully developed columella. Dr. Lea published his descriptions of *hartmanii* and *glandula* hardly three months after Anthony's names had been printed. His *hartmanii* is an old, worn and broken specimen of *amplum*. It is somewhat difficult to distinguish *glandula* from *incisum*, but I was enabled to do this with care by means of a photograph sent to me by Mr. W. B. Marshall of the United States National Museum. *Showalteriana* is a pathological individual. The synonymy of *amplum* is an illustration of a curious competition in species-naming which obtained among American naturalists in the first half of the nineteenth century.

Hinkley (2, p. 40), who found this to be the most plentiful Gyrotoma on Fort William Shoals, identified it as *constrictum*, apparently following Tryon's decision in the case of *recta*. I have seen both the type of *constrictum* and some of Hinkley's shells and can say confidently they are not the same.

The range of the species is Three-Island Shoals to Peckerwood Shoals.

UNIDENTIFIABLE SPECIES

Gyrotoma babylonicum (Lea)

Schizostoma Babylonicum Lea, Proc. Amer. Phil. Soc., IV, 1845, p. 167; Trans. Amer. Phil. Soc., X, 1848, p. 94, pl. ix, fig. 54; Obs. Gen. Unio, IV, 1848, p. 94, pl. ix, fig. 54; Journ. Acad. Nat. Sci., Phila., V, n. s., 1862, p. 248; Obs. Gen. Unio, IX, 1863, p. 70; Lewis, Amer. Journ. Conchol., V, 1869-70, p. 166; Tryon, Monog. Strepom., 1873, pp. xv, 369; Lewis, Fauna of Ala., 1876, p. 22.

Gyrotoma Babylonicum Lea, Chenu, Man. de Conchyl., I, 1859, f. 2, 021; H. & A. Adams, Genera, I, 1858, p. 305; Binney, Check List, 1860, No. 307; Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 361.

Gyrotoma lacta incisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 182.

Description: Shell striate, somewhat fusiform, rather thick, chestnut-color; spire obtusely conical; sutures impressed; whorls flattened; fissure small; aperture large, elliptical, somewhat flesh-colored within; columella smooth, angular at the base, thickened above.—Lea.

This species was described from one specimen and as from Tuscaloosa. Like Lea's *funiculatum* and his *showalterii* of 1864 it is a deformity and broken. The shell is now in the National Museum, being No. 119, 408. It is very much shouldered and is lacking in color bands. The fissure is slightly more oblique than in specimens of *pagoda* having unusually oblique fissures. It is much more oblique than in the case of *pumilum* which the shell of *babylonicum* resembles. While the mollusk does not suggest *incisum* in form, the fissure is that of many specimens of this species. I feel unable to decide as to which of these species *babylonicum* belongs. The chief characteristic upon which its specific position was established does not obtain among thousands of Gyrotoma examined. It is unquestionably an abnormal shell. If it should be decided that *babylonicum* is the same as *pumilum* the latter species, described in 1860, will go into the synonymy.

Hinkley (2, p. 41) made this shell a synonym of *wetumpkaensis* and the latter the same as *pyramidatum*. Whatever *babylonicum* may be it belongs to the members of the genus occurring at Wetumpka, while *pyramidatum* is the first species appearing in the river and does not go down to Elmore County.

Gyrotoma cylindraceum (Mighels)

Schizostoma cylindracea Mighels, Bost. Proc., I, Oct. 1844, p. 189; Tryon, Monog Strepom., 1873, pp. xv, 361; Lewis, Fauna of Ala., 1876, p. 23; Hinkley, Nautilus, XVIII, 1904, p. 40.

Gyrotoma cylindracea Migh., H. & A. Adams, Genera, I, 1858, p. 305.

Gyrotoma cylindracea Mull., Binney, Check List, 1860, No. 315.

Gyrotoma cylindracea Gould, Brot, List, 1862, p. 27; Paetel, Cat., 1888, p. 362.

Gyrotoma olivula excisa (Lea), Hannibal, Proc. Malacol. Soc., X, 1912, p. 181.

Description: Shell nearly smooth, cylindrical, thick, with slight, revolving undulations; epidermis olivaceous; spire ovate-conic, eroded; whorls three or four, flattened, shouldered; suture distinct, aperture oval; fissure deep and wide.—Mighels.

The author gave Warrior River, Alabama, as the locality for his species. Mr. C. W. Johnson informs me that the Mighels collection was destroyed in the fire which burned the quarters of the Portland Society of Natural History in 1854, another fire in 1866 destroying a second collection. The

type of *cylindraceum* must be considered lost and the species cannot be recognized with any exactness from the description. Hinkley (2, p. 40) thought the shell might be a form of *ellipticum* Anth.

SPURIOUS SPECIES

Melatoma sphaerica Anth. is apparently an Anculosa belonging to a described species of the group *A. picta* Conrad. Habitat, Coosa River, Alabama. References:

Melatoma sphaerica Anth., MSS., Reeve, Monog. Melatoma, sp. 8, April, 1861.

Schizostoma sphaericum Anth., Lewis, Amer. Journ. Conchol., V, 1869-70, p. 169; Tryon, Monog. Strepom., 1873, p. 364; Lewis, Fauna of Ala., 1876, p. 23.

Anculosa sp., Goodrich, Anculosae of Ala. River Drain., 1922, p. 56.

H. & A. Adams list *Gyrotoma altilis* Anth., *conica* Say, *curvata* Say and *foremanii* Lea. The *altilis* possibly refers to *Gillia altilis* Lea. Shuttleworth's *G. conica* may be intended or *Melania conica* Say, a Pleurocera. Tryon (10, p. 132) appears to think that *curvata* refers to *Pleurocera curvatum* Lea. Two Melanians were named *foremanii* by Lea, but neither belongs to Gyrotoma. Paetel repeats these errors and adds *aequalis* Lea, *circumlineata* Tryon, *Coosaensis* Lea, *ellipsoides* Lea, *rubicunda* Lea and *vauxiana* Lea, all belonging to other genera than Gyrotoma, besides *angulata* Lea, having reference probably to *Melania angulata* Anth., a Goniobasis.

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PLATE I

GYROTOMA

All figures of shells are 3/2 times natural size

Figures 1, 2, and 3. *G. pyramidatum* Shuttleworth. Coosa River, Ten-Island Shoals, St. Clair County. (Cat. No. 27425.)

Figures 4 and 5. *G. spillmanii* (Lea). Coosa River, Shelby County. Schowalter Collection. (Cat. No. 27426.)

Figures 6, 7, and 8. *G. pagoda* (Lea). Coosa River, Higgins Ferry, Chilton County. (Cat. No. 27427.)

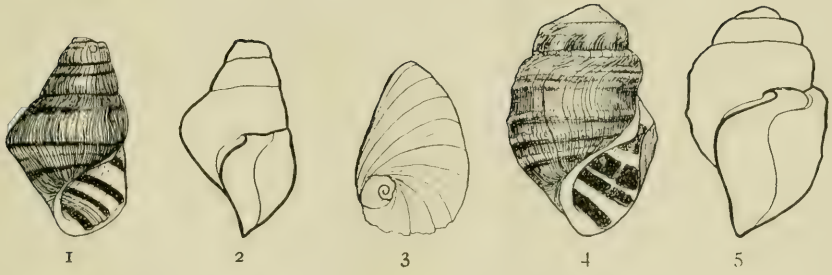
Figure 9. *G. pagoda* (Lea). Coosa River, Higgins Ferry, Chilton County. Young shell. (Cat. No. 27428.)

Figures 10 and 11. *G. pumilum* (Lea). Coosa River, Wetumpka, Elmore County. (Cat. No. 27429.)

Figures 12 and 13. *G. alabamensis* (Lea). Coosa River, Weduska Shoals, Shelby County. (Cat. No. 27430.)

Figures 14 and 15. *G. cariniferum* Anthony. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 27431.)

Figures 16, 17, and 18. *G. lewisii* (Lea). Ft. William Shoals, Talladega County. (Cat. No. 27432.)



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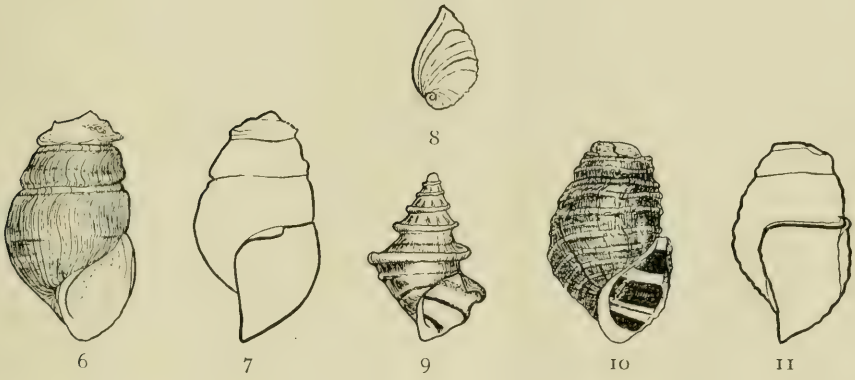

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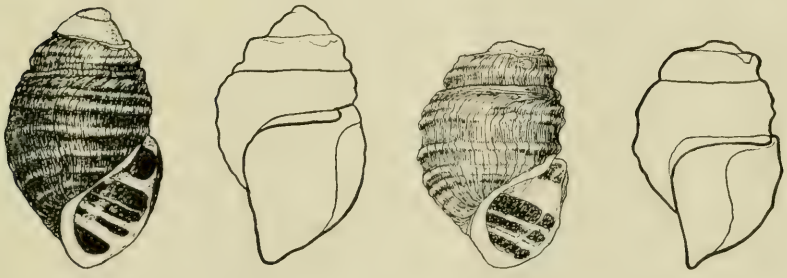

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16 17 18

PLATE 11

GYROTOMA

All figures of shells are 3/2 times natural size

Figures 19, 20, and 21. *G. hendersoni* H. H. Smith. Type. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 27433.)

Figures 22 and 23. *G. excisum* (Lea). Coosa River, Higgins Ferry, Chilton County. (Cat. No. 27434.)

Figures 24 and 25. *G. laciniatum* (Lea). Coosa River, Weduska Shoals, Shelby County. (Cat. No. 27435.)

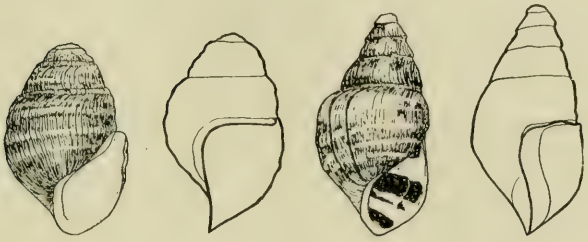
Figures 26 and 27. *G. incisum* (Lea). Coosa River, Wetumpka, Elmore County. (Cat. No. 27436.)

Figures 28 and 29. *G. incisum* (Lea). Coosa River, Weduska Shoals, Shelby County. (Cat. No. 27437.)

Figures 30, 31, and 32. *G. walkeri* H. H. Smith. Type. Coosa River, Cedar Island, Chilton County. (Cat. No. 27438.)

Figures 33, 34, and 35. *G. amplum* Anthony. Coosa River, Ft. William Shoals, Talladega County. (Cat. No. 27439.)

19 20 21



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UNIVERSITY OF MICHIGAN
MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 13

Studies of the Fishes of the Order Cyprinodontes

BY

CARL L. HUBBS

ANN ARBOR, MICHIGAN
PUBLISHED BY THE UNIVERSITY
JANUARY 18, 1924

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

STUDIES OF THE FISHES OF THE ORDER CYPRINODONTES

By Carl L. Hubbs

I. A Classification of the Fishes of the Order

II. An Analysis of the Genera of the Poeciliidae

III. The Species of Profundulus, a new Genus from Central America

IV. The Subspecies of Pseudoxiphophorus bimaculatus and of Priapichthys annectens

I. A Classification of the Fishes of the Order

1

The order Cyprinodontes Agassiz (equivalent to Microcyprini Regan) comprises certain fishes which have in the past been more or less confused, first with the Cyprinidae, then later with the Haplomi (Esox, Umbra, Dallia). Toward each of these groups the Cyprinodontes show, indeed, a superficial resemblance, but this resemblance is apparently not indicative of genetic relationship.

It has long been clear that these fishes have no close affinity with the cyprinids, but not until 1911 was their close relationship with the Haplomi critically questioned.[1]

It appears probable, in reference to the main line of evolution of fishes, that the Cyprinodontes are of distinctly more advanced organization than the Haplomi. They differ from the Haplomi and most other primitive orders of fishes, and resemble the acanthopterygian fishes in the following respects:

1. The premaxillaries alone form the margin of the upper jaw.

2. The pectoral fin is elevated in position, and the base of the fin is lateral and vertical, rather than ventral and transverse (in Dallia alone among the Haplomi the pectoral fin resembles that of the Cyprinodontes, but in that genus the basal bones are highly modified: the resemblance is not indicative of relationship).

3. The pelvic fins are more anteriorly inserted.

4. The pelvic rays are not more than 6 in number.

5. The vertebrae are typically reduced in number.

6. The larval adhesive organ, which the writer has found retained in *Esox lucius* of the Haplomi, is apparently never developed in any of the Cyprinodontes.

[1] Regan, *Ann. Mag. Nat. Hist.*, 7, 1911, p. 323.

7. Finally, a fact perhaps most conclusively indicative of a more advanced organization, the branchiostegal rays of the Cyprinodontes are of the acanthopterygian type, whereas those of the Haplomi are of a distinctly more generalized type.[2]

II

The writer agrees with Jordan[3] that the old family Poeciliidae or Cyprinodontidae should be dismembered. While as a whole Jordan's division of the group seems sound, in certain details it apparently requires modification.

The subfamily Fundulinae is equivalent to the Haplochilinae (properly the Aplocheilinae) of Garman, a name of earlier date. The Orestiidae might better be regarded also as a subfamily (Orestiinae) of the Cyprinodontidae.

The Characodontidae and Goodeidae should not be separated, for to do so would destroy the extreme naturalness of the combined group. The name Characodontinae is synonymous with Goodeinae, which is the older; the family should therefore be named Goodeidae. This family may best be divided into two groups (quite unlike those recognized by Jordan), namely, the **Zoogoneticinae** (new subfamily name), containing Zoogoneticus and Girardinichthys, and characterized by the simple teeth and short intestine, and the Goodeinae proper, consisting of Characodon, Chapalichthys, Goodea and Skiffea, and characterized by the bicuspid teeth and more or less elongate intestine.

The Poeciliidae (misprinted Poecilidae) may be accepted as outlined by Jordan, except that four generic names listed under this family should be transferred to the Cyprinodontidae. These names follow: Gambusinus, Cynodonichthys, Ilyodon (relationship doubtful) and Cynopoecilus.

The Fitzroyidae and Anablepidae should probably be reduced to subfamily rank, for the latter group was very probably derived from the former. The name Anablepidae holds for the combined group, being the older. The name Fitzroyinae must be altered to Jenynsiinae, according to the international rules as at present interpreted (Fitzroyia and Jenynsia were proposed in the same work by Günther; Fitzroyia has page priority, but the name Jenynsia was accepted by the earlier writers, who regarded the two genera as synonymous).

III

The families of Cyprinodontes may therefore stand as follows:

Cyprinodontidae
Adrianichthyidae
Goodeidae
Anablepidae
Poeciliidae
Phallostethidae
Amblyopsidae

[2] See Hubbs, *Jour. Morph.*, 33, 1919, p. 67.

[3] A classification of fishes including families and genera so far as known. *Stanford Univ. Publ.* (*Biol. Sci.*), 3, 1923, pp. 77-243, i-x.

GONOPODIA OF POECILIIDAE PLATE III

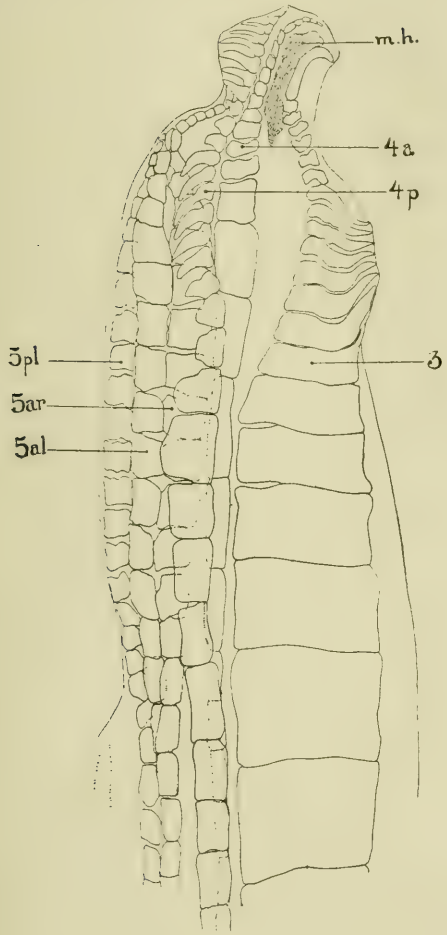

FIGURE 4

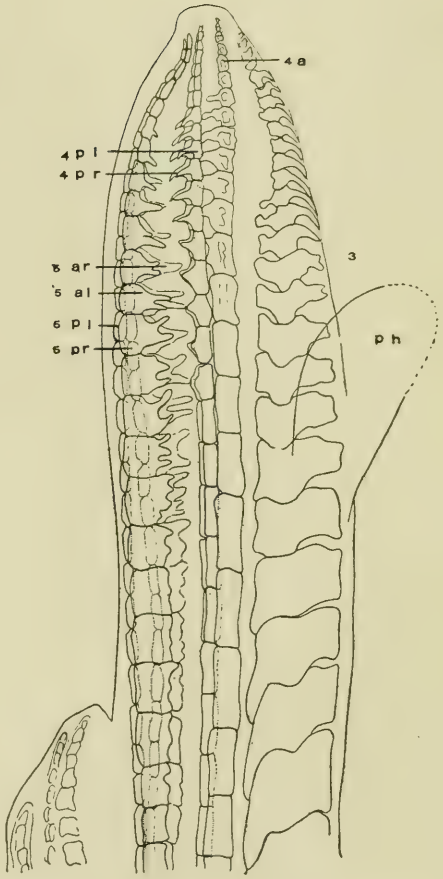

FIGURE 5

PLATE IV

Figure 6. Distal portion of the gonopodium of *Allopoecilia caucana,* from a specimen 26 mm. long to caudal fin, from Rio Camarones at Arroyo de Arena, Colombia.

Figure 7. Distal portion of the gonopodium of *Mollienisia latipinna,* from a specimen 51 mm. long, from Louisiana. In figures 6 and 7 the membranous hook is labelled *m h,* the retrorse segment at tip of ray 5, *r s.*

GONOPODIA OF POECILIIDAE PLATE IV

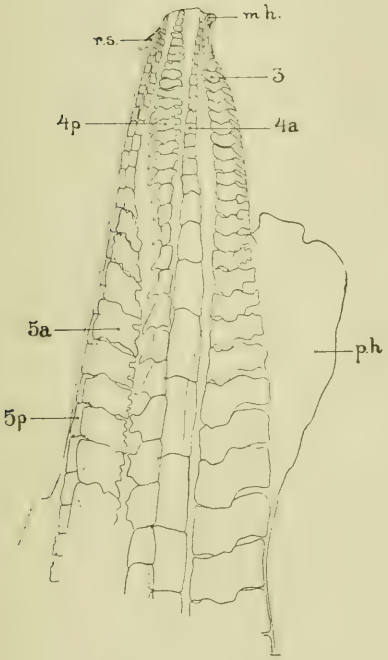

FIGURE 6

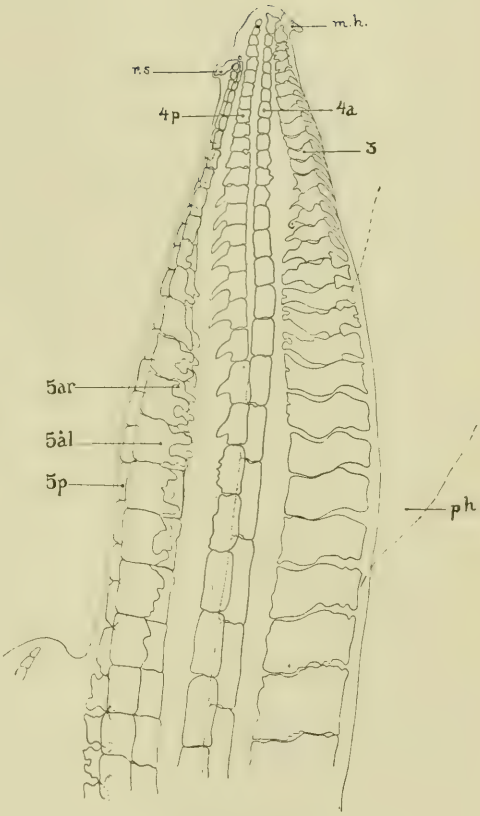

FIGURE 7

II. AN ANALYSIS OF THE GENERA OF THE POECILIIDAE

I

Since 1913, when Regan published A Revision of the Cyprinodont Fishes of the Subfamily Poeciliinae,[1]—an epoch-making work in the study of this group of tropical American fishes,—a number of new types have been discovered, and new light has been thrown on the characters and relationships of forms previously described. It seems advisable, therefore, to bring this revision by Regan up to date and to include at the same time some original observations and deductions.

As Regan's review demonstrated, by far the most valuable of all the characters which have been used in the classification of these little fishes are those taken from the structure of the gonopodium[2] (this is the intromittent organ of the male, formed by the elongation and singular elaboration of rays 3, 4 and 5 of the anal fin; see figures). With the aid of gonopodial characters, Regan and other writers have been able to demonstrate repeatedly that species which previously had been closely associated together in reality should be distributed to distant parts of the series, and that species which had been widely separated in the older classifications were, nevertheless, very closely related. In the older systems the characters chiefly used involved the length of the intestine and the shape and arrangement of the teeth, features correlated closely with food, and now known to have been repeatedly and independently altered on the different lines of evolution within the family (these characters still appear to be of high value in the classification of the Poeciliidae, however, even now that it has been shown that they cannot safely be employed in the primary division of the group).

Unfortunately, males are often not taken, even when a considerable series of these fishes are collected, or, if taken, the males may be either young or non-breeding individuals, in either case not showing the characteristic structure of the gonopodium. Unless a species is known and recognized, it cannot be certainly classified in the absence of males with perfect gonopodia; usually even its approximate position in the series cannot be determined. In fact, species of one cyprinodont family known only from females may be, as they have been at various times, placed in genera belonging to another family of the group.

Gonopodia may be quickly mounted on a slide, using preferably the glycerine sodium silicate medium recently described by Creaser and Clench,[3] and thus readily studied and drawn with the aid of a microscope, or, better, of a projection apparatus. In routine identification most of the gonopodial features may be made out with the aid of a 12X or 18X hand lens.

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[1] Regan, *Proc. Zool. Soc. London*, 1913, pp. 977-1018; figs. 168-173, and pls. 99-101. The Poeciliinae of Regan are equivalent to the Poeciliidae of the present paper.

[2] Gonopodia were figured and used as systematic characters as early as 1848 (Heckel), 1855 (Poey), and 1907 (Eigenmann), but Regan was the first to use gonopodial characters in a comprehensive revision of the entire group.

[3] *Trans. Am. Micr. Soc.*, 42, 1923, pp. 69-71.

II

The gonopodium is the chief distinctive feature of the Poeciliidae (as here delimited). In the other groups of viviparous cyprinodonts the anal fin, to be sure, is also modified as an intromittent organ, but in so different a fashion as to indicate an entirely independent origin as compared with the gonopodium. It is highly probable that the Goodeidae, Poeciliidae and Anablepidae, as well as the remarkable Phallostethidae of the Malay Peninsula, originated independently from the oviparous Cyprinodontidae.[4] It is, therefore, probable that viviparity has been independently acquired four times among the cyprinodont fishes. If this view is correct, we have in the present case a most striking example of the independent attainment, within one group of animals, of one end through diverse adaptation. The oviparous Cyprinodontidae, it would further follow, have had and probably still possess the potentiality of developing viviparity. In fact, many of the species of this family show an approach toward the viviparous condition in the development of clasping structures and habits.[5]

In the following key to the genera of the Poeciliidae the family is divided into four subfamilies,—the Gambusiinae, Poeciliopsinae, Poeciliinae and Tomeurinae. These groups are of unequal size, but are recognized as coördinate because each appears to have evolved from the basal stock of the whole family, each being characterized by certain primitive as well as specialized features. Of the four subfamilies, the Gambusiinae are without question the least specialized, while Tomeurus is the most highly modified poeciliid.

Within these subfamilies certain clusters of genera may be recognized, by reason of the remarkable coördination which they display between geographical distribution and gonopodial structure, as distinct groups of independent origin. As it is planned to return later to a fuller consideration of these phenomena, it seems desirable to assign definite names to these groups. For this purpose the term *tribe* (with the ending -ini) may be borrowed from entomology.

III

In the key one new subfamily, nine new tribes, nine new genera, and one new species are diagnosed. A list of these new names follows:

New subfamily name: Poeciliopsinae.

New tribe names: Gambusiini, Heterandriini, Girardinini, Cnesterodontini, Pamphoriini, Xiphophorini, Poeciliini, Alfarini, Tomeurini.

New genera: Panamichthys, Allogambusia, Darienichthys, Alloheterandria, Phallichthys, Xenophallus, Neopoecilia, Parapoecilia, Allopoecilia.

New species: *Neopoecilia holacanthus.*

[4] The major classification of the cyprinodont fishes is considered in the preceding paper of this series.

[5] See Newman, *Biol. Bull.*, 12, 1907, pp. 314-348, 3 pls. and 22 figs.

IV

AN ANALYSIS OF THE GENERA OF THE POECILIIDAE

A[1].—Lower edge of caudal peduncle rounded, with a median series of normal scales. Pelvic fins well developed in both sexes, and inserted behind the base of the pectorals.

B[1].—Pelvic fins alike in the two sexes. Gonopodium elongate; the two halves of posterior branch of ray 5 not separated.

C[1].—Rays of the gonopodium not imbricated so as to form an enclosed tube, all lying strictly in the same plane (see figures 1, 2, and 4-7). Jaws firmly united (except in Girardinus).....Gambusiinae.

D[1].—Terminal segment of ray 3 (of anal fin in male = first prolonged ray of gonopodium) not forming a specialized transverse process.

E[1].—Ray 5 and posterior branch of ray 4 each with a small, usually retrorse hook at its extremity; anterior branch of ray 4 with a thickened node, which is sharply produced, except in Belonesox, to form the "elbow." (Tribe **Gambusiini**).[6]

F[1].—Jaws normally formed. Thickened node of ray 4 shorter but more sharply produced, forming a well-defined "elbow" (see figure 1).

G[1].—Ray 3 without erect spinules; serrae of ray 4 less modified, and wholly apicad to elbow; apical processes of rays 4 and 5 scarcely hooked. Dorsal fin more posteriorly inserted (about twice as distant from eye as from base of caudal in female).....Heterophallus.[7]

G[2].—Ray 3 with erect spinules more or less sharply developed; serrae of ray 4 better developed, in part at least and usually wholly proximad to elbow; apical processes of rays 4 and 5 strongly hooked, except in one subgenus (undescribed). Dorsal fin less posteriorly inserted.. .....Gambusia.

F[2].—Jaws produced into a short beak. Thickened node of ray 4 longer and not sharply produced to form a well-defined "elbow"; ray 3 without erect spinules; serrae of ray 4 sharply developed and wholly proximad to thickened node; apical processes of rays 4 and 5 scarcely hooked.... .....Belonesox.

E[2].—Ray 5 and posterior branch of ray 4 each without a trace of a retrorse hook at or near the tip, the posterior branch of ray 4 not entering into the distal modification of the gonopodium; the anterior branch of ray 4 not provided with a thickened node, except in Allogambusia[8] (see figure 2).

H[1].—Ray 3 without a pair of curved, horn-like appendages; ray 5 always smooth on posterior edge. (Tribe **Heterandriini**).[9]

I[1].—Ray 3 without developed serrae. Teeth conical (slightly compressed in Heterandria).

J[1].—Ray 3 without definite processes of any kind; ray 4 with no trace of an enlarged node resembling the "elbow" of the Gambusiina.

K[1].—Rays 4 and 5 contiguous distally, or nearly so, never separated by a notch in the membrane; rays 3 and 4 not together supporting a small knob.

L[1].—Rays 4 and 5 both entering into the formation of tip of gonopodium.

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[6] Gambusiini, new name (as a tribe name).

[7] Regan, *Ann. Mag. Nat. Hist.*, (8) 14, 1914, p. 66, fig. A. Haplotype, *Heterophallus rachovii* Regan, from Vera Cruz, Mexico.

[8] The thickened node of ray 4 in Allogambusia is probably of independent origin, as the genus does not otherwise especially resemble the Gambusiini, and as the node differs in certain details from the "elbow" of the group.

[9] Heterandriini Hubbs, new tribe name.

M¹.—Gonopodium rather short; ray 4 curved more or less backward at tip.....Brachyrhaphis.

M².—Gonopodium rather longer and more slender; ray 4 curved forward at tip.

N¹.—Tip of gonopodium gently recurved; ray 5 evenly and gently curved; serrated segments of ray 4 numerous..... .....Priapichthys.[10]

N².—Tip of gonopodium abruptly curved forward to form a hook-like appendage; ray 5 arched backward behind the few serrae of ray 4.....**Panamichthys.**[11]

L².—Anterior branch of ray 4 alone entering into the formation of the specialized forward-curved tip of the long gonopodium (see figure 2).

O¹.—Terminal segment of ray 4 greatly elongate; anterior edge of ray 4 roughened, the posterior edge with numerous serrae. Teeth strictly conical, and mouth with a developed lateral gape. Dorsal fin much longer and inserted farther forward than anal. Size of fish moderate. Sexual dimorphism slight .....Pseudoxiphophorus.

O².—Terminal segment of ray 4 much less notably enlarged; anterior edge of ray 4 smooth, the posterior edge with few serrae (see figure 2). Teeth somewhat compressed, the mouth more strictly transverse. Dorsal fin about equal in size and opposite in insertion to anal. Size minute. Sexual dimorphism sharp ..... Heterandria.

K.²—Rays 4 and 5 not contiguous distally, separated by a notch in the membrane; the finely segmented tip of the anterior branch of ray 4 and the elongated terminal segment of ray 3 together supporting a small knob at tip of fin.....Priapella.

J².—Ray 3 with a short, suberect, curved spur near tip; anterior branch of ray 4 with a much enlarged node somewhat resembling the "elbow" of the Gambusiini.....**Allogambusia.**[12]

I².—Ray 3 with developed serrae along its anterior edge; ray 3 without trace of any processes other than the serrae; anterior branch of ray 4 curved forward distally (straight in Alloheterandria), and alone extended to the extreme tip of the gonopodium. Teeth conical or compressed.

P¹.—Ray 3 abruptly hooked forward and upward at tip; anterior branch of ray 4 slender throughout, and without an enlarged terminal segment; the posterior branch of ray 4 with the serrae weak, few, and widely separated from tip of ray. Teeth conical..... .....**Darienichthys.**[13]

P².—Ray 3 scarcely curved forward at tip.

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[10] Priapichthys Regan. Type (as designated by Jordan), *Gambusia annectens,* the only species the gonopodium of which was known to Regan. The other species which have been referred to Priapichthys are not strictly congeneric with *Priapichthys annectens.*

[11] Panamichthys Hubbs, new genus. Type species, *Priapichthys panamensis* Meek and Hildebrand (*Pub. Field Mus., Zool.,* 10, 1916, p. 322). One species, *P. panamensis.*

[12] Allogambusia Hubbs, new genus. Type species, *Gambusia tridentiger* Garman, *Mem. Mus. Comp. Zool.,* 19, 1895, p. 89, pl. 4, fig. 10 (*Priapichthys tridentiger* Meek and Hildebrand, *Publ. Field Mus., Zool.,* 10, 1916, p. 320, fig. 6). Two species, *A. tridentiger* Garman and *A. cana* Meek and Hildebrand.

[13] Darienichthys Hubbs, new genus. Type species, *Gambusia dariensis* Meek and Hildebrand, *Publ. Field Mus., Zool.,* 10, 1913, p. 88 (*Priapichthys dariensis,* Meek and Hildebrand, *ibidem,* 10, 1916, p. 321, fig. 7). One species known, *D. dariensis.*

Q¹.—Anterior branch of ray 4 with an enlarged terminal segment; posterior branch of ray 4 with the serrae few but strong, extending nearly to tip of ray; serrae of ray 3 short.

R¹.—Terminal segment of gonopodium not curved, but with a backward directed spinelet; segments of anterior branch of ray 4 everywhere slender. Mouth with a lateral cleft; teeth conical. Size of fish small.....**Alloheterandria.**[14]

R².—Terminal segment of gonopodium strongly curved forward, and without spinelets; two subterminal segments of anterior branch of ray 4 considerably thickened. Mouth vertical; teeth somewhat expanded at tip. Size minute.....Neoheterandria.[15]

Q².—Anterior branch of ray 4 with the terminal segment not enlarged; posterior branch of ray 4 with the serrae more numerous, but not nearly extended to tip of ray; serrae of ray 3 long. Teeth incisor-like; mouth without developed lateral cleft.....
.....Pseudopoecilia.

H².—Ray 3 with a pair of curved horn-like appendages near tip; ray 5 with the posterior edge serrate. (Tribe **Girardinini.**)[16]

S¹.—Bones of the lower jaw firmly united; the teeth fixed.

T¹.—Teeth of the outer row spear-shaped and widely spaced....Toxus.

T².—Teeth of outer row chisel-shaped and close-set.....Glardichthys.

S².—Bones of lower jaw loosely connected; teeth of outer row movable, spatulate ..... Girardinus.

D².—Terminal segment of ray 3 forming a more or less highly specialized process. (Tribe **Cnesterodontini.**)[17]

U¹.—Process not trowel-like.

V¹.—Process not forked, nor antler-like.

W¹.—Process short, with a simple and slight curve; ray 3 with serrae on both edges. Teeth of outer row conic.....Diphyacantha.[18]

W².—Process inordinately elongate, with a strong, double curve; ray 3 without developed serrae. Teeth of outer row chisel-shaped, followed by a single series of conical teeth.....Cnesterodon.

V².—Process forked, and each fork antler-like. Teeth of outer row oar-shaped, slender, followed by a band of villiform teeth.....Phalloceros.

U².—Process trowel-shaped; a most remarkable structure, formed like a relatively immense scoop, with a compressed horn on each side, and attached to the fin by a narrow pedicel. Teeth oar-shaped, in a single series.....
.....Phallotorynus.[19]

C².—Rays of the gonopodium imbricated so as to form an enclosed tube on right side of fin (see figure 3).....**Poeciliopsinae.**

X¹.—Gonopodium without horn-like appendages; ray 4 not forming a hook at its tip.

Y¹.—All well developed serrae of ray 4 directed backward.

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[14] Alloheterandria Hubbs, new genus. Type species, *Gambusia nigroventralis* Eigenmann and Henn, *Indiana Univ. Studies,* No. 16, 1912, p. 26 (*Priapichthys nigroventralis* Henn, *Ann. Carn. Mus.,* 10, 1916, p. 115, fig. 3). In addition to *A. nigroventralis, Gambusia caliensis* Eigenmann and Henn, in Henn, *l. c.,* p. 113, may prove to belong to this genus.

[15] Neoheterandria Henn, *Ann. Carn. Mus.,* 10, 1916, p. 117, fig. 5. Haplotype, *Neoheterandria elegans* Henn, from Colombia.

[16] Girardinini Hubbs, new tribe name.

[17] Cnesterodontini Hubbs, new tribe name.

[18] Diphyacantha Henn, *Ann. Carn. Mus.,* 10, 1916, p. 113, fig. 2. Haplotype, *Diphyacantha chocoensis* Henn.

[19] Phallotorynus Henn, *Ann. Carn. Mus.,* 10, 1916, p. 126, figs. 8-13. Haplotype, *Phallotorynus fasciolatus* Henn, from Brazil.

Z^1.—Mouth with a lateral cleft; bones of lower jaw firmly connected; teeth fixed and conical.....Leptorhaphis.

Z^2.—Mouth with the cleft transverse and vertical; bones of the lower jaw loosely connected; teeth movable and somewhat compressed.

a^1.—Body deep and the form not distorted. Dorsal inserted farther forward than anal. Gonopodium longer, reaching nearly or quite to caudal base when depressed; posterior branch of ray 4 not nearly reaching tip of fin.....**Phallichthys.**[21]

a^2.—Body slender, and distorted in form, as usual in Gambusia. Dorsal inserted farther back than anal. Gonopodium of moderate length, not reaching caudal base when depressed; posterior branch of ray 4 nearly reaching tip of fin.....**Poeciliopsis.**[22]

Y^2.—Well developed serrae of ray 4 directed forward and outward in part. Other characters as here given for Poeciliopsis.....Phalloptychus.

X^2.—Gonopodium with two prominent horn-like appendages,—one, like the excrescence on a pelican's bill, on the front edge of ray 3; the other a long curved horn attached at base to posterior edge of ray 4. Other characters as here given for Leptorhaphis.....**Xenophallus.**[23]

B^2.—Pelvic fins enlarged and modified in the male, the first ray with a soft swollen tip, the second ray thickened and usually much elongated. Ray 5 of anal fin in male (the last ray of the gonopodium) forming a trough posteriorly, the two sides of the posterior branch of the ray being widely separated, and more or less twisted to one side; ray 3 with a membranous swelling along anterior margin (characters not known for the Pamphoriini).....Poeciliinae.

b^1.—Gonopodium elongate, about one-third as long as the body. Bones of the lower jaw more firmly united. Inner ventral rays abruptly shorter than the second ray. (Tribe **Pamphoriini.**)[24]

c^1.—Teeth of outer series slender, pointed; bones of lower jaw firmly united.....Pamphorichthys.

c^2.—Teeth of outer series broad incisors; bones of lower jaw somewhat less firmly united.....Pamphoria.

b^2.—Gonopodium short. Bones of lower jaw loosely united. Teeth of outer series rather slender, spatulate.

d^1.—Membranous swelling on front of gonopodium not forming a definite prepuce-like hood; ray 3 ending in a very large and strong hook, about the end of which the tip of the anterior branch of ray 4 is curved; posterior branch of ray 4 with serrae both distal and proximal to tip of ray 5; ray 5 arched backward toward tip (see figure 4). Inner rays of ventral of male not abruptly shorter than the second ray. (Tribe **Xiphophorini.**)[25]

e^1.—Ray 5 not ending in a hook. Caudal alike in the two sexes; dorsal fin shorter, with 9 to 11 rays.....Platypoecilus.

e^2.—Ray 5 ending in a backward-directed hook. Lower rays of caudal fin in the male ending in a long, sword-like appendage; dorsal fin longer, with 13 to 15 rays.....Xiphophorus.

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[20] Poeciliopsinae Hubbs, new subfamily name.

[21] Phallichthys Hubbs, new genus. Type species, *Poeciliopsis isthmensis* Regan. *Poeciliopsis isthmensis* from Panama and *Poecilia pittieri* Meek from Costa Rica are probably identical with *Poeciliopsis amates* Miller, from Guatemala and Honduras (a specimen from Tela, Honduras, is at hand).

[22] Poeciliopsis Regan. Type, *Poecilia presidionis* Jordan and Culver (as designated by Henn, 1916; not *Poeciliopsis isthmensis* as designated by Jordan, 1920).

[23] Xenophallus Hubbs, new genus. Type species, *Gambusia umbratilis* Meek, *Publ. Field Mus., Zool.*, 10, 1912, p. 70 (type material, from Costa Rica, re-examined).

[24] Pamphoriini Hubbs, new tribe name. This tribe perhaps belongs in the Gambusiinae, the distinctive features of its two genera not being well known.

[25] Xiphophorini Hubbs, new tribe name.

d^2.—Membranous swelling along anterior margin of gonopodium modified into a prepuce-like hood; ray 3 with at most a very small hook; ray 4 straight or nearly so, with serrae only proximal to end of ray 5; ray 5 not arched backward (see figures 5-7). Inner ventral rays abruptly shorter than the second ray. (Tribe **Poeciliini.**)[26]

f^1.—Ray 5 with the last segment of the posterior branch not elongate, nor sharply retrorse (see figure 5).

g^1.—Tips of all rays very slender; ray 3 with either serrae or a terminal hook.

h^1.—Ray 3 serrate along anterior margin, not abruptly nor extensively slender at tip, and without a trace of a terminal hook.

i^1.—Anterior branch of ray 4 strictly entire on both margins; anterior edge of ray 5 more or less roughened, but hardly spinous..Poecilia.

i^2.—Both branches of ray 4 serrate on posterior margin; anterior edge of ray 5 with long spines (see figure 5) .....**Neopoecilia.**[27]

h^2.—Ray 3 without developed serrae, and abruptly narrowed distally to form a long, slender tip, which bears a terminal hook.....Limia.

g^2.—Tip of ray 3 and of posterior branch of ray 4 markedly clavate; ray 3 lacking both serrae and terminal hook.....**Parapoecilia.**[28]

f^2.—Ray 5 with the last segment of the posterior branch elongate and abruptly retrorse, entering the posterior profile of the gonopodium (see figures 6 and 7).

j^1.—Ray 3 without processes on posterior margin; terminal hook of same ray weakly or not at all developed. Fishes of minute size.

k^1.—Tips of all the rays of the gonopodium slender; anterior as well as posterior branch of ray 4 serrate on posterior margin; serrae of ray 3 strong; terminal hook of ray 3 wholly undeveloped. Sexual dimorphism in color and size strongly marked.....Lebistes.

k^2.—Tips of ray 3 and of posterior branch of ray 4 clavate (but less so than in Parapoecilia); posterior branch only of ray 4 serrate; serrae of ray 3 weak; terminal hook of ray 3 often weakly developed (see figure 6). Sexual dimorphism slight.....**Allopoecilia.**[29]

j^2.—Ray 3 with long, more or less spinous processes on posterior margin; terminal hook of same ray always strongly developed; tips of all the rays slender; posterior branch only of ray 4 serrate; serrae of ray 3, strong (see figure 7). Larger fishes, with sexual dimorphism slightly marked (except in the development of the dorsal fin).....Mollienisia.

A^2.—Lower edge of the caudal peduncle sharp, without a median series of scales. Pelvic fins better developed in the male sex. Bones of lower jaw firmly united; teeth conical .....Tomeurinae.

l^1.—Pelvic fins well developed in both sexes, located behind the base of the pectoral fins. Gonopodium very simple in structure, without appendages or serrae; ray 3 with knob-like enlargement. Body rather deep. (Tribe **Alfarini**)[30]....Alfaro

l^2.—Pelvic fins absent in female, minute and below gill opening in male. Gonopodium with long appendages. Body elongate (tribe **Tomeurini**).[31]...Tomeurus.

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[26] Poeciliini Hubbs, new name (as a tribe name).

[27] Neopoecilia Hubbs, new genus. Orthotype, *Neopoecilia holacanthus* Hubbs, new species (based on the material recorded as *Poecilia vivipara* by Evermann and Marsh, in *Bull. U. S. Fish Comm.*, 1900 (1902), p. 97).

[28] Parapoecilia Hubbs, new genus. Type species, *Limia hollandi* Henn, from Brazil (Henn, *Ann. Carn. Mus.*, 10, 1916, p. 138, fig. 17).

[29] Allopoecilia Hubbs, new genus. Type species, *Girardinus caucanus* Steindachner (*Mollienisia caucana* Henn, *Ann. Carn. Mus.*, 10, 1916, p. 136, fig. 16).

[30] Alfarini Hubbs, new tribe name.

[31] Tomeurini Hubbs, new name as a tribe name.

III. THE SPECIES OF PROFUNDULUS, A NEW GENUS FROM CENTRAL AMERICA

I

Profundulus, new genus

Orthotype, *Fundulus punctatus* Günther

Several closely related species from Central America, hitherto referred to Fundulus, Adinia, or Zoogoneticus, comprise a natural group, differing from Fundulus as here restricted in several important respects.

The lateral rims of the genital aperture of the adult female are scarcely produced, surrounding not more than the first anal ray: thus not forming the genital pouch diagnostic of Fundulus. The anal fin in the adult male is lower, instead of higher, than in either the young or the adult female.

The dorsal and anal fins are relatively long and low, the anal especially being composed of more rays (13-17) than usual in Fundulus. The two fins are inserted far posteriorly, and near the same vertical, somewhat as in a pike.

The interorbital is more convex, the head being formed more like that of an Umbra than that of a Fundulus.

In the absence of a genital pouch, at least, the species of Profundulus resemble those[1] comprising the African group Nothobranchius[2] (*walkeri, orthonotus, melanospilus, neumanii, guentheri, taeniopygus,* and possibly others, such as *sjoestedti* and *microlepis*). All of these African types, however, have a much narrower preorbital.

Another African species, commonly referred to Fundulus, namely, *capensis,* has the dorsal fin more advanced in position than in Profundulus, while the remainder[3] have higher and sharper vertical fins, and mouths of different structure.

II

As the more generalized members of Fundulus, Cynolebias and some other American genera of the Cyprinodontidae, as well as the less specialized Goodeidae, resemble the species of Profundulus in habitus, it seems not improbable that Profundulus, of all American genera, diverges least from a general ancestral cyprinodont type. The geographical distribution of the groups in question harmonizes with such a view.

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[1] For descriptions, figures and references, see Boulenger, *Cat. Fresh-water Fishes of Africa,* 3, 1915, pp. 23-29.

[2] Recognized by Regan (*Ann. Mag. Nat. Hist.,* 7, 1911, p. 324) as distinct from Fundulus.

[3] *Fundulus nisorius* Cope, described as from West Africa, is excluded from present consideration, as it was probably based on American material erroneously labelled.

III

Four or more species of Profundulus may be distinguished. Two are from the Atlantic, the others from the Pacific drainage of Central America.

1. *Profundulus punctatus* Günther

Fundulus punctatus Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 320 (original description; page priority over *guatemalensis*); Trans. Zool. Soc. London, 6, 1868, p. 482, pl. 84, fig. 5 (redescription of types, with figure); Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 637 (after Günther); Meek, Publ. Field Mus. (Zool.), 5, 1904, p. 104; *ibid.*, 7, 1907, p. 136; Regan, Biol. Centr. Am., Pisces, 1907, p. 78 (excepting *oaxacae* in synonymy); Fowler, Proc. Acad. Nat. Sci. Phila., 68, 1916, p. 47.

Fundulus guatemalensis Günther, Cat. Fishes Brit. Mus., 6, 1886, p. 321 (original description); Trans. Zool. Soc. London, 6, 1868, p. 482, pl. 84, figs. 3, 4 (redescription of types, with figures); Meek, Publ. Field Mus. (Zool.), 5, 1904, p. 103; *ibid.*, 7, 1907, pp. 136, 184.

?Fundulus guatemalensis Eigenmann, Proc. U. S. Nat. Mus., 13, 1891, p. 64 (Western Ecuador; locality probably erroneous).

Adinia guatemalensis Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 660 (*punctatus* was here retained in Fundulus!).

Zoogoncticus guatemalensis Meek, Publ. Field Mus. (Zool.), 3, 1903, p. 94 (name only; the species erroneously and uncritically placed in the unrelated new genus Zoogoneticus).

Fundulus pachycephalus Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 321 (a doubtful synonym of *punctatus*, which has page priority); Trans. Zool. Soc. London, 6, 1868, p. 483, pl. 84, fig. 6 (type figure and redescription of type); Regan, Biol. Centr. Am., Pisces, 1907, p. 77.

Fundulus parvipinnis Garman, Mem. Mus. Comp. Zool., 19, 1895, p. 100 (in part: *Profundulus punctatus* confused with *Fundulus parvipinnis!*).

Specimens collected by George P. Engelhardt in the Rio de Moka, Guatemala, were identified with this species by Dr. S. E. Meek, but the record was never published. All of the material published on by Dr. Meek (see synonymy) has been re-examined. I provisionally follow Regan in uniting the nominal forms *guatemalensis* and *punctatus* under one specific name. The specimens at hand from (the outlet of) Lake Amatitlan, regarded by Meek as typical of *guatemalensis*, are, it is true, of stouter build and paler coloration than stream specimens (typical *punctatus*). But some of the specimens from the outlet of the lake show evident, though indistinct, spots on the dorsal and caudal fins, and closely resemble the type of *punctatus* in the form and general coloration of the body. The degree of spotting is also very variable in stream specimens. Hence it is provisionally assumed that the name *guatemalensis* was based on well-nourished, pale-colored lake specimens of *punctatus*, and that the form is at most only racially distinct.

Counts and Measurements of Profundulus punctatus

Locality	*San Jose de Idolo, Guatemala*		*Mazatenango, Guatemala*							*Outlet of Lake Amatitlan*					
Scales: long.	34	34	34	33	33	34	33	34	32	34	33	33	34	33	32
Scales: trans.[4]	12	12	12	12	12	12	12	12	12	12	12	11	12	12	12
Fin-rays, dorsal	13	..	11	12	12	12	11	12	12	12	11	11	10	12	13
Fin-rays, anal	14	14	14	15	14	15	13	14	14	13	14	13	14	13	15
Length, mm.	57	53	51.5	57	62	60	61	73	42	45	48	54	65	68	72
Depth, body	3.6	..	3.3	3.5	3.6	3.4	3.4	3.4	3.2	3.1	3.4	3.6	3.25	3.4	3.15
Origin of dorsal to base of caudal	2.8	2.65	2.85	2.9	2.75	2.75	2.9	2.9	2.7	2.95	2.85	2.75	2.75	2.85	2.65
Length, head	3.7	3.65	3.35	3.65	3.7	3.75	3.65	3.7	3.3	3.35	3.5	3.4	3.5	3.4	3.6
Length, eye	4	4.1	4	3.7	4.2	4.3	4	4.5	4	4.1	4.1	4.3	4.6	4.6	4.6
Length, snout	3.3	3.4	3.1	3.1	3.35	3.4	3.35	3.25	3.4	3.2	3.5	3.1	3.5	3.2	3.3
Width, interorbital	2.2	2.25	2.2	2.2	2.25	2.2	2.2	2.2	2.2	2.3	2.25	2.3	2.2	2.2	2.2
Width, preorbital	3.6	3.3	3.2	3.6	3.5	3.6	3.3	3.5	3.4	3.3	3.6	3.2	3.5	3.7	3.3
Width, head	1.25	1.5	1.35	1.4	1.3	1.3	1.3	1.3	1.4	1.35	1.45	1.35	1.35	1.35	1.35

[4] The transverse scale count in Profundulus is taken from the base of the pelvic fin directly upward to and including the mid-dorsal series.

2. *Profundulus oaxacae* Meek

Fundulus oaxacae Meek, Publ. Field Mus. (Zool.), 3, 1902, p. 90 (original description); *ibid.,* 5, 1904, p. 104, fig. 28 (redescription and figure of type material).

Fundulus punctatus Regan, Biol. Centr. Am., Pisces, 1907, p. 78 (in part).

As also in *P. labialis* and *P. punctatus,* the anal fin is higher in the female than in the male; it is also high in the young, as in *punctatus.*

Re-examination of Dr. Meek's types from Oaxaca seems to confirm the validity of his species. It is a smaller fish than *punctatus,* and the eye is smaller than in specimens of the Guatemalan species of comparable size (see measurements of each). The scales average fewer in the longitudinal series, but more in the transverse series. The dorsal and anal fins are nearly unicolor, whereas in *punctatus* these fins have a light marginal band, just within which the dark pigment is intensified. The two species, however, are very closely related, and may prove identical (as Regan has held after examining more abundant material).

Counts and Measurements of Profundulus oaxacae

Locality, Oaxaca, Mexico

Scales: long.[5]	31[6]	30	31	32	33	31
Scales: trans.[7]	13	13	13	12	12	13
Fin-rays, dorsal	12[8]	11	12	11	11	11
Fin-rays, anal	15	13	14	13	13	13
Length, mm.	48	47	44	43	43	39
Depth, body	3.65	3.4	..	3.6	3.8	3.3
Origin of dorsal to base of caudal	2.85	2.9	3.0	3.0	2.9	2.85
Length, head	3.7	3.5	3.4	3.4	3.5	3.4
Length, eye	4.7	4.7	4.6	4.5	4.5	4.0
Length, snout	3.35	3.2	3.4	3.5	3.6	3.4
Width, interorbital	2.2	2.3	2.4	2.35	2.4	2.3
Width, preorbital	3.5	3.6	3.7	3.4	3.7	3.6
Width, head	1.45	1.5	1.5	1.4	1.6	1.5

3. **Profundulus candalarius,** new species

Holotype, a male specimen 73 mm. long to base of caudal; collected with a female paratype of 68 mm. in a limestone spring at Candalaria, near the Mexican boundary of Guatemala, 6 leagues distant from Nenton, on June 1, 1906. This is in the basin of the Rio Chiapas of the Atlantic drainage. The specimens were collected by Mr. O. F. Cook, and both are deposited in the Field Museum of Natural History.

P. candalarius in general appearance is similar to *P. labialis* Günther, the only species hitherto known in the Atlantic drainage, it having been taken from Lake Yzabal and from the basin of the Rio Chisoy, tributary thereto.

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[5] In five others: 30, 30, 31, 32, 32.

[6] Holotype.

[7] In five others: 12, 12, 12, 13, 13.

[8] Miscounted 14 in original description.

From *labialis, candalarius* differs in the number of fin-rays and scales, in which characters it agrees with the Pacific species (*punctatus* and *oaxacae*). From these two species *candalarius* differs in form and proportions, as noted in the course of the following description.

In its form *Profundulus candalarius* suggests a pike. The back is heavy at the shoulders, but flat in profile back to the posteriorly inserted dorsal fin. The top of the head is flatter than in related species, both transversely and longitudinally; the anterior profile is a little incurved. The snout is rather more produced and pointed than in the Pacific species. Depth of body, 3.4 (3.5) in total length, minus the caudal; least depth of caudal peduncle, 2.3 (2.2) in head, 1.35 (1.6) in its length from anal fin. Length of head, 3.25 (3.6); eye, 4.5 (4.5), larger than in the species of the Pacific drainage; upper jaw, 3.2 (3.6), not reaching to below eye; least preorbital width, 2.7 (2.8) in postorbital length of head, decidedly wider than in *punctatus* and *oaxacae*. The body and the head are much more compressed than in the species just named: greatest width of head, 1.65 (1.7) in its length; least interorbital width, 2.5 (2.5). Branchial aperture free to upper opercular angle. Gill-rakers only about as long as the pupil, 15 (16) on the lower limb of the outer arch. Teeth in rather broad bands in the jaws, the outer series a little enlarged.

Scales larger than in *P. labialis,* in 33 (35) rows from branchial aperture to caudal base, 12 (13) longitudinal rows from pelvic fin to and including the mediodorsal series.

Fin rays: dorsal, 12 (12); anal, 14 (15); pelvic, 6 (developed rays). Dorsal fin set farther backward than in *punctatus* and *oaxacae,* the interval between its origin and the caudal base being contained 3.2 (3.2) times in the total length without caudal, rather than from 2.65 to 3.1 times. In the male holotype the dorsal fin is just as high as long, the anal a little longer than high; in the female specimen the dorsal is a little higher than long, while the two dimensions of the anal are about the same. The broad caudal is truncate behind; the pectoral is broadly rounded; the pelvic short, not nearly reaching to anus. The intestine is little coiled.

The coloration is not very distinctly preserved. The scales of the male type are light where exposed, but marked by dark crescents at their bases; dark streaks are evident between each of the longitudinal scale rows. There is a dark axillar blotch. The fins are not distinctly marked; the anal probably had a light margin. The female specimen is rather plainly colored, the scales marked by dark reticulations; an indistinct dark lateral streak was apparently developed; coloration of fins as in the male.

IV. THE SUBSPECIES OF PSEUDOXIPHOPHORUS BIMACULATUS AND OF PRIAPICHTHYS ANNECTENS

I

Two species of cyprinodont fishes from Middle America exhibit geographical variation sufficiently well defined and extensive as to require division into subspecies. These species are *Pseudoxiphophorus bimaculatus* of southern Mexico and Guatemala, and *Priapichthys annectens* of Costa Rica.

II

Pseudoxiphophorus bimaculatus Heckel

This species, which inhabits the Atlantic drainage from central Mexico to Guatemala, comprises a complex of races distinguished only by average, intergrading characters. Provisionally it may be divided into three subspecies, two of which have been regarded as distinct species. Of these subspecies, the typical *bimaculatus* is intermediate, the two extreme subspecies being *P. b. taeniatus* Regan and *P. b. jonesii* Günther. These subspecies form a series grading from *jonesii* of the higher mountain streams and lakes of east-central Mexico through the intermediate *bimaculatus* of the lower and somewhat warmer waters back of Vera Cruz into the more southern form.

The characters which distinguish these subspecies are those of form and proportions, color, and, particularly, the number of dorsal rays. From extreme *taeniatus* to *jonesii*, that is, toward the north and toward higher elevations, the body becomes deeper, the head longer, the color paler, the dorsal rays reduced in number. The difference in the number of dorsal rays is summarized in the following table:

Frequency table.—Number of dorsal rays in the three subspecies of Pseudoxiphophorus bimaculatus:

	Number of dorsal rays						
	11	*12*	*13*	*14*	*15*	*16*	*17*
P. b. jonesii	15	51	9	6	3	..	..
P. b. bimaculatus	..	1	29	21	3	..	..
P. b. taeniatus[1]	..	..	..	7	13	4	1

The correlations of these variational phenomena will be considered by the writer in a subsequent paper.

Pseudoxiphophorus bimaculatus jonesii Günther

Mollienisia jonesii Günther, Ann. Mag. Nat. Hist., (4) 14, 1874, p. 371; Garman, Mem. Mus. Comp. Zool., 19, 1895, p. 52; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 698.

Gambusia jonesii Regan, Ann. Mag. Nat. Hist., (7) 19, 1907, p. 260; Biol. Centr. Am., Pisces, 1907, p. 97, pl. 12, fig. 8.

Pseudoxiphophorus jonesii Regan, Proc. Zool. Soc. London, 1913, p. 993.

[1] Miller, in recording specimens from Guatemala, gave the dorsal rays as 10 to 17, but no one else has found fewer than 14 rays in the dorsal fin of any specimen of this species found so far south. Perhaps Miller confused some other species with the present one.

Pseudoxiphophorus bimaculatus Woolman, Bull. U. S. Fish. Comm., 14, 1894, p. 65; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 1, 1896, p. 678; Meek, Publ. Field Mus., Zool., 5, 1904, p. 127 (in part).

Pseudoxiphophorus pauciradiatus Regan, Ann. Mag. Nat. Hist., (7) 13, 1904, p. 256; (7) 16, 1905, p. 362.

The pertinence of *Mollienisia jonesii* to the present genus and its approximate identity with his own *pauciradiatus* has already been indicated by Regan.

The material of this form examined is part of that recorded by Woolman (1894), as *Pseudoxiphophorus bimaculatus,* from the Rio Blanco at Orizaba. This is the type locality of *pauciradiatus.*

Pseudoxiphophorus bimaculatus bimaculatus Heckel

Xiphophorus bimaculatus Heckel, Sitz. Akad. Wiss. Wien, 1, 1848, p. 296, pl. 9, figs. 1, 2.

Pseudoxiphophorus bimaculatus Bleeker, Ichth. Arch. Ind. Prodr., Cypr., 2, 1860, p. 485; Atl. Ichth., 3, 1863, p. 140; Troschel, in Müller's Reise Mexico, 3, App., 1865, p. 104; Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 332; Garman, Mem. Mus. Comp. Zool., 19, 1895, p. 81, pl. 3, fig. 6, and pl. 8, fig. 9; Bean, Proc. U. S. Nat. Mus., 21, 1898, p. 541; Meek, Publ. Field Mus., Zool., 3, 1902, p. 98; Regan, Ann. Mag. Nat. Hist., (7) 13, 1904, p. 256; Meek, Publ. Field Mus., Zool., 5, 1904, p. 127 (in part); Regan, Proc. Zool. Soc. London, 1913, p. 993, fig. 170C (in part); Cockerell, Proc. Biol. Soc. Wash., 28, 1915, pp. 153, 156.

Gambusia (*Pseudoxiphophorus*) *bimaculata* Regan, Ann. Mag. Nat. Hist., (7) 19, 1907, p. 260.

Gambusia bimaculata Regan, Biol. Centr. Am., Pisces, 1907, p. 98 (in part).

(?) *Poecilioides bimaculatus* Steindachner, Sitzb. Akad. Wiss. Wien, 48, 1863, p. 176, pl. 4, fig. 2; Troschel, in Müller's Reise Mexico, 3, App. 1865, p. 104 (not *Xiphophorus bimaculatus* Heckel).

Pseudoxiphophorus reticulatus Troschel, in Müller's Reise Mexico, 3, App., 1865, p. 104; Günther, Cat. Fishes Brit. Mus., 6, 1866, p. 333.

The typical subspecies of *Pseudoxiphophorus bimaculatus* inhabits the streams back of Vera Cruz, chiefly at moderate elevations.

In material collected by Meek the dorsal rays vary as indicated in the following table:

Frequency table.—Dorsal rays in Pseudoxiphophorus bimaculatus bimaculatus:

	Dorsal rays			
	12	*13*	*14*	*15*
San Francisco River basin at Xico and Jalapa	1	24	9	2
Blanco River basin at Cordoba	..	1	10	1
Papaloapan basin at Obispo, Perez and El Hule	..	4	2	..

Pseudoxiphophorus bimaculatus taeniatus Regan

Pseudoxiphophorus bimaculatus Meek, Publ. Field Mus., Zool., 5, 1904, p. 127 (in part); Regan, Ann. Mag. Nat. Hist., (7) 16, 1905, p. 363; Miller, Bull. Am. Mus. Nat. Hist., 23, 1907, p. 105 (in part?); Regan, Proc. Zool. Soc. London, 1913, p. 993, fig. 170C (in part).

Gambusia bimaculata Regan, Biol. Centr. Am., Pisces, 1907, p. 98 (in part).

Pseudoxiphophorus bimaculatus var. *taeniatus* Regan, Ann. Mag. Nat. Hist., (7) 16, 1905, p. 363; Biol. Centr. Am., Pisces, 1907, p. 98, pl. 14, fig. 4.

The name *taeniatus* was proposed by Regan, as a "variety," to distinguish a form from San Domingo de Guzman, southern Mexico, the distinctive features as pointed out being the development of a median longitudinal stripe and a higher number of dorsal rays. Since the color feature will probably prove to be only a phase without geographical significance, and since the high number of rays appears to be a general characteristic of the southern form of the species, it is here proposed to use the name *taeniatus* for that subspecies.

The range of *taeniatus* may then be extended to cover the Atlantic drainage of the Isthmus of Tehuantepec, Guatemala and British Honduras.

Frequency table.—Number of dorsal rays in Pseudoxiphophorus bimaculatus taeniatus:

		Dorsal rays			
Locality	Authority	*14*	*15*	*16*	*17*
Sanborn, Mexico	Hubbs	1	2	..	..
Rio Tonto, Mexico	Regan (1905)	5	7	3	..
San Domingo de Guzman, Mexico	Regan (1905)	..	1	..	1
San Domingo de Guzman, Mexico	Regan (in lit.)	1	2	1	..
Belize, British Honduras	Hubbs	..	1	..	..

III

Priapichthys annectens Regan

This species as here construed includes two subspecies: typical *annectens,* of the lowland streams on the Atlantic slope of Costa Rica, and the new subspecies *hesperis,* inhabiting the headwaters of the Rio Grande de Tarcoles, a Pacific stream. The form *hesperis,* when compared alone with typical *annectens,* appears to represent a distinct species, but the differences between the two forms are found to be bridged over when one determines the characters of series from Rio Reventazon, which flows down the east slope of Costa Rica opposite these headwaters of the Tarcoles. The connection between the two forms is not by an even areal intergradation, but rather by what may be termed *mosaic intergradation.*

Excluding for the present the intermediate races of the Reventazon basin, the differences between the two subspecies of *Priapichthys annectens* may be expressed as follows:

Character	*annectens*	*Intermediate races*	*hesperis*
Head in length, in adult female	3.5 to 3.75	3.6 to 4.2, rarely to 4.5	3.8 to 4.35
Eye in head	3.0 to 3.7	2.9 to 3.75	3.6 to 4.3
Mouth	usually narrower	various	usually wider
Pigment of margins of scale pockets	tending to form spots	various	less concentrated

Finally, the dorsal rays are reduced in number in the subspecies *hesperis,* as is indicated in the following tabulation:

Frequency table.—Number of dorsal rays in the two subspecies of Priapichthys annectens:

	Dorsal rays				
	8	*9*	*10*	*11*	*Average*
P. a. annectens	..	..	22	6	10.21
Intermediate races	1	54	28	1	9.34
P. a. hesperis	3	79	18	..	9.15

Comparison will show that the differences between the *Tierra Caliente* and the mountain forms of *Priapichthys annectens* are rather closely paralleled by the differences which distinguish the races of *Pseudoxiphophorus bimaculatus* inhabiting respectively the same types of environment. Further emphasis will be given this point in a paper to follow the present one.

Priapichthys annectens annectens Regan

Gambusia annectens Regan, Ann. Mag. Nat. Hist., (7) 19, 1907, p. 259; Biol. Centr. Am., Pisces, 1907, p. 97, pl. 14, figs. 5-7.

Priapichthys annectens Regan, Proc. Zool. Soc. London, 1913, p. 992, fig. 170B; Meek, Publ. Field Mus., Zool., 10, 1914, p. 114 (in part).

A series of specimens from Parismina, Costa Rica, taken by Dr. Meek in the Rio Parismina, a lower tributary of the Reventazon, agrees closely with the type-description of *Gambusia annectens* Regan. Hence it is taken as typical of the subspecies *Priapichthys annectens annectens*. The 23 females vary in length to caudal from 18 to 58 mm.; the three males, from 28 to 34 mm. The 6 adult females more than 40 mm. long vary in proportions as follows: greatest depth of body, 3.0 to 3.3; length of head, 3.65 to 3.75; snout, 3.1 to 3.3, longer than eye (but no longer than eye in smaller females, "as long as or shorter than eye," according to Regan); eye, 3.3 to 3.7; scales, 28 to 30; dorsal rays 10 or 11 (ten in 19 specimens, eleven in 6); anal rays, 9, the fin not strongly falcate (except in some young). The coloration consists principally of conspicuous black borders around the scale pockets, the pigment on the ventral part of the scales becoming mostly concentrated to form a round black spot at apex of scale pocket; the spots forming longitudinal rows, somewhat as in Gambusia. Along the posterior half of the axial series of scales the black spots become transversely divided, one portion being located above, the other below, the middle of the scale. In some specimens the spots on the scales above and below the axial series have been shifted from their normal median position to a location adjacent to that of the divided spot of the scales of the axial series, which then appear to be bounded above and below by a zig-zag line. On young specimens dark transverse bars extend across the posterior half of the body, passing through every second or third scale of the axial series. In both sexes the bars become faint with age and, in the females at least, completely disappear.

Three half-grown females from Guápiles (spelled Guapilis by Dr. Meek), taken in the Rio Guápiles, an upper tributary of the Rio Negro which flows toward the mouth of the San Juan, agree with the females of the series from Parismina described above. Dorsal, 10; anal, 9.

Priapichthys annectens: races intermediate between *P. a. annectens* and *P. a. hesperis.*

Gambusia annectens Meek, Publ. Field Mus., Zool., 7, 1907, p. 145 (in part).

Priapichthys annectens Meek, Publ. Field Mus., Zool., 10, 1914, p. 114 (in part).

Under this head there are recorded several series of specimens, mostly from the valley of the Rio Reventazon, and all showing traits variously inter-

mediate between those of *P. a. annectens* on the one side and those of *P. a. hesperis* on the other.

1. *Chitaria;* elevation, 340 meters. One female, 48 mm. long to caudal base: depth, 3.3; head, 3.8; snout, 3.4; eye, 3.4; scales, 28; dorsal rays, 9; anal, 9, the fin not strongly falcate. This specimen has the large eye and the coloration of *annectens,* but only 9 dorsal rays, as in *hesperis,* and the head of intermediate length.

2. *El Guayabo;* elevation, 360 meters. Five females, 44 to 56 mm. long to caudal: depth, 3.0 to 3.4; head, 3.6 to 3.9; snout, 3.3 to 3.4; eye, 3.0 to 3.5; scales, 29 or 30; dorsal rays, 10 (four specimens) or 11 (one). These specimens have the large head, large eye, and the number of dorsal rays of typical *annectens,* but the dark margins of the scale pockets are not concentrated into spots.

Another series from Guayabo, collected by J. F. Ferry, contains: (1) young females with the typical coloration of *annectens;* (2) four males, 24 to 30 mm. long to caudal; (3) four females, resembling the lot described above, 42 to 50 mm. long. The adult females present these variations: head, 3.6 to 3.9; eye, 2.9 to 3.2; scales, 29 or 30; dorsal rays, 9 (three specimens), as in *hesperis.*

3. *Turrialba;* elevation, 600 meters. One female, 40 mm. to caudal: depth, 3.4; head, 3.65; snout, 3.0; eye, 3.2; scales, 29; dorsal rays, 9; anal, 9, strongly falcate. This specimen agrees with typical *annectens* in proportions and coloration, but with *hesperis* in the number of dorsal rays.

4. *Tucurrique;* elevation, 941 meters. Four females, 40 to 49 mm. long; head, 3.6 to 4.0; eye, 3.0 to 3.4; scales, 29 to 31; dorsal rays, 9 (all four specimens); anal strongly falcate; dark margins of scale pockets concentrated ventrally into spots, which are not divided along axis of fish. The fishes of this lot have the proportions of *annectens,* but only 9 dorsal rays, as in *hesperis.*

5. *Quebrada de los Negros;* elevation, (?). Twenty-six females, varying in length to caudal base from 34 to 52 mm. The specimens of this lot more than 45 mm. long have the following characteristics: head, 3.8 to 4.2; eye, 3.2 to 3.6; scales, 29 to 31; dorsal rays, 9 (ten specimens) or 10 (16 specimens); anal more or less strongly falcate; coloration as in the Tucurrique lot. The specimens of this series have the large eye characteristic of typical *annectens,* but in the size of the head and in the number of dorsal rays they are intermediate between typical *annectens* and the subspecies *hesperis.*

6. "*Quebradilla*" (this locality cannot be found on the available maps, but according to a note left by Dr. Meek with the specimens, Quebradilla is on the Atlantic slope of Costa Rica). A large series collected by Dr. A. Alfaro, including about fifty males 21 to 29 mm. long. Eight females, 51 to 59 mm. long to base of caudal, have the following proportions: head, 3.8 to 4.5; snout, 2.7 to 3.3; eye, 3.4 to 3.75; scales, 29 or 30; dorsal rays, 8 to 10 (eight in one specimen, nine in 35, ten in 8); anal strongly falcate. This series has the general appearance of *hesperis,* but the eye is not quite so small as in that subspecies.

Priapichthys annectens hesperis, new subspecies

Gambusia annectens Meek, Publ. Field Mus., Zool., 7, 1907, p. 145 (in part).
Priapichthys annectens Meek, Publ. Field Mus., Zool., 10, 1914, p. 114 (in part).

This new form is represented in the collections of the Field Museum of Natural History by a very large series of specimens from San José, Costa Rica, a city on the Rio María Aquilar, an upper tributary of the Rio Grande de Tárcoles (elevation, 1,165 meters); and from Tobosi (1,200 meters); and San Isidro (1,260 meters), on other tributaries of the same stream. Lower in the same basin the species appears to be replaced by *Brachyrhaphis olomina*.

The holotype is a female, 59 mm. long, from San José. Many female paratypes are nearly as large, but the largest male among about 125 is 49 mm. in length, and none of the other males are longer than 36 mm.

Body rather heavy; dorsal contour rather strongly arched before the dorsal fin, its greatest point of elevation being midway between tip of snout and base of caudal (in smaller specimens the dorsal contour is less strongly arched, and its highest point is at the origin of the dorsal fin); the belly is rounded; greatest depth of body in length to caudal base, 2.8 (2.8 to 3.4); caudal peduncle deep, its length from anal fin to base of caudal, 2.8 (2.8 to 3.2) in length of body; least depth of caudal peduncle, 1.35 (to 1.45) in head. The head is short, broad, and deep; its length to end of opercle, 4.3 (3.8 to 4.35) in length of body; its greatest breadth, 1.3 in its length; its depth below occiput, equal to (or a little shorter than) its length. The flatness of the top of the head is continued backward with decreasing width to the dorsal fin; least interorbital width, 1.8 (1.7 to 1.9). Length of the broadly rounded snout, 3.2 (2.8 to 3.3); diameter of the eye, 3.7 (3.6 to 4.3), larger, of course, in smaller specimens. The mouth is oblique and broad, but with well-developed lateral cleft; teeth conic, pointed, in bands, those of the outer series spaced and moderately enlarged.

Scales in 31 (29 to 31) series.

Color in alcohol brownish, becoming lighter on the belly and on the flattened back, but without a definite dark streak along the mid-dorsal line, nor along the axial line of the body, nor along the edges of the caudal peduncle. The scale-pockets are broadly margined with blackish brown except on the under part of the body. In smaller females the scales on the lower part of the body frequently have their pigment concentrated into apical spots, but usually neither so definitely nor so extensively as in *H. a. annectens;* as in that form the pigment of the median three rows of scales tends to be concentrated along the upper and lower margin of the scales of the axial series posteriorly. Small females have dark vertical bars in the posterior part of the body, separated by one or two scales. The dorsal fin is dark, with a row of interradial black spots near base of fin; caudal dark to light dusky, the scales on its base with conspicuous dark borders; anal and paired fins dusky.

Fins usually smaller than *annectens* proper, but variable. The dorsal is composed of 9, sometimes 10, rarely 8, rays, and its origin is nearly as close to the caudal base as to the head, usually but not always farther back than in *annectens* proper. The caudal is usually short and truncate, as long as (or a fifth longer than) the depth of the caudal peduncle. Anal composed

of 9 rays, the third to the fifth being prolonged to form a short lobe, rendering the edge of the fin strongly falcate; these are the same rays which in the male are much more produced to form the gonopodium; the origin of the anal is midway between the base of caudal and a point behind the eye equal to half or all its diameter. The paired fins are broadly rounded and short, the pectoral being about as long as the postrostral length of the head, the ventrals reaching only two-thirds the distance to the anus or to the origin of the anal fin.

The male, as mentioned before, is much smaller than the female. Its body, while actually not deeper, appears to be so, as the back is more strongly arched; the body is decidedly more compressed; the width of the head is contained about 1.6 times in its length. The proportions are like those of the young females, or like the adult females of *annectens* proper. The coloration and color range agree with those of the female. The dorsal fin is inserted midway between the base of the caudal and the anterior half of the postorbital length of the head; the origin of the anal midway between base of caudal and tip of mandible; the ventral fins extend to the origin of the anal.

The gonopodium (intromittent organ) is elongate, reaching when depressed nearly to the lower procurrent rays of the caudal fin. Its finer structure is like that of *annectens* proper. The organ is developed from the third, fourth, and fifth anal rays when the fish has reached a length of about 20 mm. to caudal. Over one hundred males were examined with the organ developed; in length these specimens vary from 21 to 49 mm., few being more than 30 mm. long, and only the largest being longer than 36 mm. In the specimens from 21 to 36 mm. long the serrae-bearing segments of the second produced ray vary in number from 8 to 12, averaging fewer in the smaller specimens than in the larger ones; in the largest male (49 mm. long) the number is increased to at least 18. The number of serrae doubtless increases with age, as might well be expected, for one serra is developed from each of the distal articulations of the ray, and the number of articulations, of course, increases with age.

EXPLANATION OF FIGURES

All of the figures are of gonopodia, the intromittent organ formed by the modification of rays 3, 4 and 5 of the anal fin in the male. In each figure the rays are numbered, and if divided the anterior (a), median (m) and posterior (p) branches of each ray are lettered as indicated; further, the left (l) and right (r) halves of certain branches are also shown, and so lettered. The gonopodia are all shown as semitransparent objects, and all, with the exception of that of *Poeciliopsis lutzi* (figure 3) are viewed from the left side. All the figures were drawn with the aid of a projection machine in order to secure accuracy of proportions; detailed corrections of the outlines of individual segments were made while the object was being examined under a high power of the microscope.

PLATE I

Figure 1. Distal portion of gonopodium of *Gambusia puncticulata,* from a specimen 26 mm. long to caudal fin, from Havana, Cuba. The terminal hooks of rays 4 and 5 are indicated by the letters *t h.*

Figure 2. Distal portion of the gonopodium of *Heterandria formosa,* from a specimen 12.5 mm. long to caudal fin, from De Leon Springs, Florida.

GONOPODIA OF POECILIIDAE PLATE I

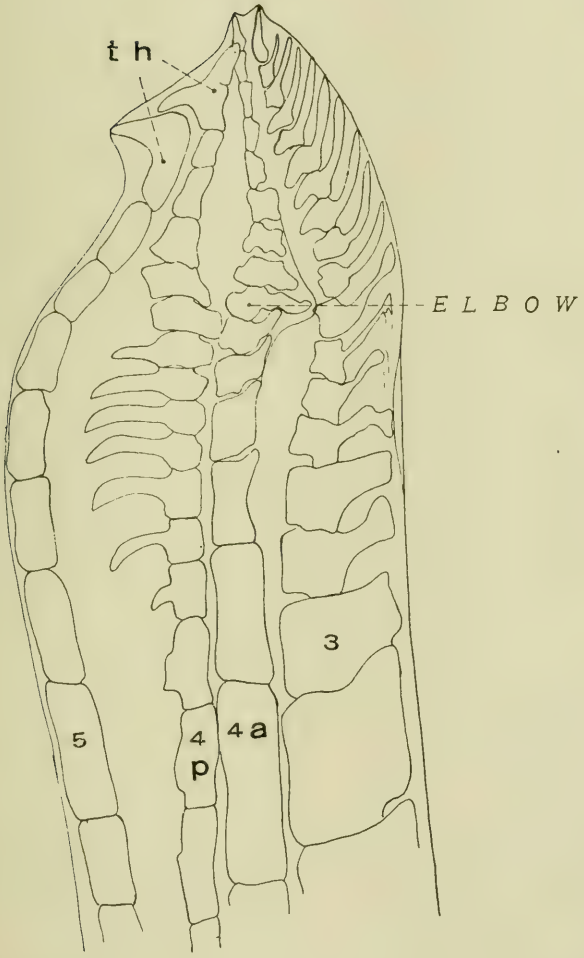

FIGURE 1

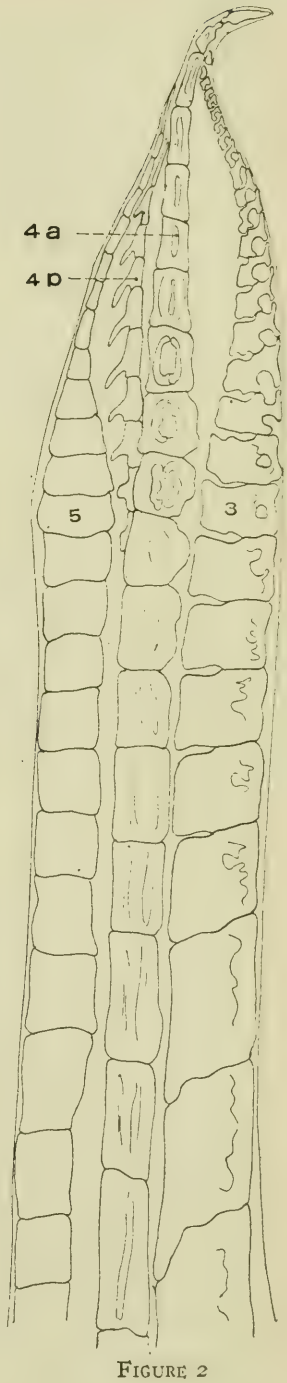

FIGURE 2

PLATE II

Figure 3. Distal portion of the gonopodium of *Poeciliopsis lutzi,* from a specimen 26 mm. long to caudal fin, from San Juan, a village in Acayucan, Mexico. Figure *A* shows the right side of the gonopodium, while figures *B* to *F* digrammatically show in oblique views, the cross-cut ends of the gonopodium at various indicated levels; the latter are introduced to show the complex imbrication of the rays to form a tube, and the bilateral asymmetry of the two halves of certain rays The crescentic horn in the membranous tip of the gonopodium is indicated by the letters *ch.*

GONOPODIA OF POECILIIDAE PLATE II

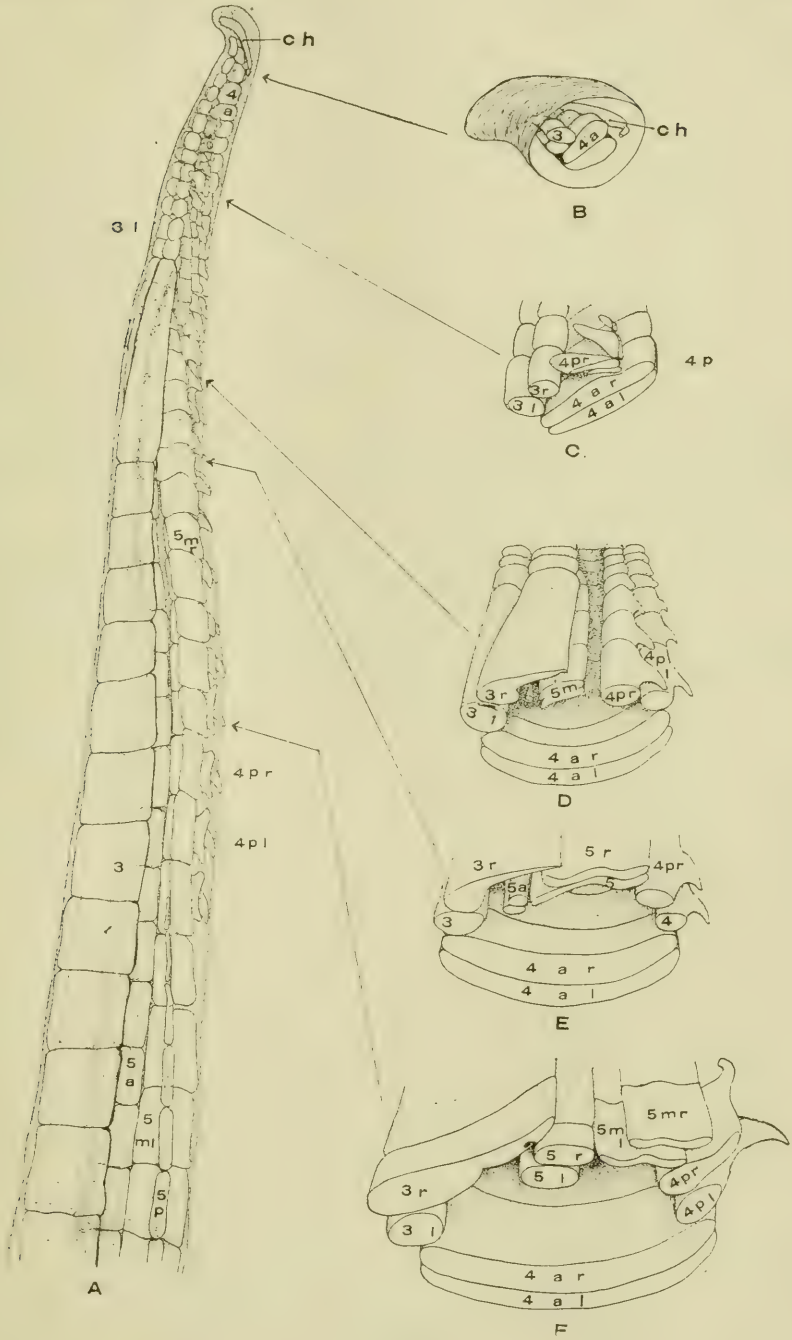

FIGURE 3

PLATE III

Figure 4. Distal portion of the gonopodium of *Platypoecilus maculatus*, from a specimen 23 mm. long to caudal fin. The membranous hook is labelled *m h.*

Figure 5. Distal portion of the gonopodium of *Neopoecilia holacanthus*, from a specimen 34.5 mm. long, from Arroyo, Porto Rico. The prepuce-like hood in this and the following two figures is indicated at *p h.*

UNIVERSITY OF MICHIGAN
MUSEUM OF ZOOLOGY

Miscellaneous Publications No. 14

The Genus Perilestes (Odonata)

BY
E. B. WILLIAMSON
AND
J. H. WILLIAMSON

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Alexander G. Ruthven,
Director of the Museum of Zoology,
University of Michigan.

THE GENUS PERILESTES (ODONATA)

By E. B. Williamson and J. H. Williamson

The genus Perilestes contains three hitherto described species to which six are added in this paper. They are of similar general appearance and have long slender abdomens and relatively short wings. They bear a striking superficial resemblance to species of the protoneurine genus Protosticta of the Oriental fauna. The obvious superficial difference is in the shape of the apical segments of the female where Protosticta has the characteristic protoneurine apical enlargement beginning at the apex of segment 6, while in Perilestes 7 is only of normal size, and the great development in Perilestes of segment 9 into an almost globular form does not occur in Protosticta, though both have the segment relatively very large when compared with the abbreviated eighth segment.

The genus is characterized by the following venational characters: the apical posterior angle of the quadrangle reaches the wing margin, M_3 arises at the first or between the first and second postnodals and Rs arises from the fifth to the ninth postnodal. Kennedy has erected for the genus the subfamily Perilestinae of the family Lestidae. It had been placed in the Legion Podagrion by De Selys (Megapodagrioninae of more recent authors). The genotype is *fragilis* Hagen as redescribed in this paper.

Generic and Specific Characters

In addition to the venational characters mentioned above, which make the recognition of the genus an easy matter, the species have a number of other characters in common. The dorsum and rear of the head are black, largely shining and with greenish or bronzy reflections. The thorax is dark striped with pale, the sterna are black, and the abdomen is patterned in light and dark colors, the most striking of which is a bright pale ventral area on the apical segments of the male. The wings are hyaline with unicolored stigmas and largely black venation. The legs are moderate in length, rather weak and with a few relatively long spines. The two to five basal spines in the ventro-anterior row of the first femur are modified similarly to those forming the comb-like grouping of spines in the same row near the apex of the first tibia. The superior male appendages are forcipate, and the inferior appendages are rudimentary. In the female the valves of the ovipositor are smooth along the ventral edge except at the extreme apex where each valve terminates in two strong, nearly equal, ventrad directed teeth, these two teeth in tandem, one anterior to the other.

Specific differentials are given in the synoptic key and in the descriptions which follow. They may be briefly indicated. In Group II, probably including the more primitive species of the genus, the venation is more reduced than in species of Group I, as indicated especially by the origin of M_{1a}. In counting the cells behind Cu_2 we have used as the apical point

the first cell basal to the first cell extending from Cu_1 to the wing margin. Usually there are scattered or more or less continuous double cells between Cu_1 and the wing margin distal to the first single cell behind Cu_1, so the real termination of Cu_2 is indefinite, but it seemed that no more precise way of indicating this character could be employed. There is a real difference in the development of Cu_2 in different species and the method of counting cells as we have done indicates this as accurately as any other method. In fact the only other method is to begin at the most distal double cell between Cu_1 and the wing margin and count the marginal cells from there to the origin of Cu_2. Another venational character, which occurs occasionally and which gives a rather peculiar venational pattern but which offers no difficulty to precise description or tabulation, is the arising of M_2 and R_s at the same level. More rarely they are separated at their origin by two postnodal spaces.

There are two colors of stigmas, black (brown in tenerals) or distinctly reddish brown. Both colors exist in each group. The posterior border of the hind lobe of the prothorax and the mesostigmal lamina offer specific characters. The color of the face, the leg color pattern, the abdominal color pattern, especially of segments 3-5, and in the female of segment 9, and the color of the metasternum differ in different species. In the male the anterior lamina with its posterior process, the second hamule and especially the superior abdominal appendages offer specific characters. In the male of *remotus* the anal plate is more conspicuous in dorsal view than in any other species. The longer anterior lamina of species of Group I, as compared with Group II, is associated with a relatively longer second segment in species of Group I. The length of the ovipositor is a specific character.

Historical

Hagen, in 1862 (in De Selys' Syn. des Agrionines, Legion Podagrion), described the genus Perilestes and the species *fragilis* from two female specimens, one from Congonhas, Brazil, the other, a smaller female, from the Essequibo River, British Guiana. The specimens were in two European museums and there is nothing to indicate that direct comparison of the two was ever made. At the present time there are several reasons for thinking the two specimens are not conspecific and no reason for thinking they are. In this paper the name *fragilis* is retained for a Brazilian species.

In the Revision du Syn. des Agrionines, Premiere Partie, 1886, De Selys adds to the original generic description and describes a male and female (or females) from the Amazon, referring them doubtfully to *fragilis* which he knew only from Hagen's inadequate description, but in the final paragraph proposing the name *cornuta* for the Amazonian specimens if they should later prove different from the two females described by Hagen. The name *cornuta* (*cornutus*) is retained in this paper for one of the five known Amazonian species and it is assumed that the two

or more specimens seen by De Selys are really conspecific, though females in this genus are not readily recognized. But it happens that *cornutus* belongs to one group in the genus while the remaining four Amazonian species belong to another group, and these groups are venationally distinct. De Selys calls attention to this character in the male, and almost certainly recognized it in the female. Of the latter sex he probably had more than one specimen, as he gives two measurements for the female abdomen, but the text, excepting the localities, implies a single specimen of each sex.

Immediately following the description of *cornutus* De Selys describes *attenuata* (*attenuatus*), apparently from a single female collected by Bates at Santarem. The description is so complete that we are able to almost certainly identify one of the four Amazonian species of the group to which *attenuatus* certainly belongs as that species.

Calvert in the B. C. A. doubtfully refers a single immature male from Costa Rica to *fragilis*. This is a specimen of *remotus* described in this paper. In the Odonata of the Neotropical Region he discusses two males and two females from Chapada, Brazil, and summarizes in a tabulation the characters of these specimens, of *cornutus* from De Selys' description, and of the Costa Rican male, but because of the inadequacy of the earlier descriptions he was unable to certainly identify the Chapada specimens which were referred doubtfully to *fragilis*. We have examined these specimens, through the kindness of Mr. Kahl, and they are discussed below under the name *solutus*.

Relationships within the Genus and Geographical Distribution

Species of Perilestes are found from Costa Rica in the north to Rio Janeiro, Brazil, in the south, approximately between parallels 10° north and 25° south. In South America at least, they are confined to the Atlantic drainage. The genus probably had its origin in the Brazilian highlands. Two well defined groups, as indicated in the synoptic key to groups and species, exist in the genus. Group I of this key is northern, Group II southern. The northern extension of Group I may indicate that this group originated during the time of and on the front ranks of the invasion of the present Amazonian valley.

The northern Group I of four species has only one species in the Amazonian basin. *Cornutus,* while clearly a member of Group I, is very distinct from the remaining three species of the group. It has been taken on the upper Amazon and on the Madeira River and is thus widely separated geographically from the nearest member of the same group, *guianensis,* known certainly only from French Guiana and doubtfully from British Guiana. The two remaining species of the group, *magdalenae* and *remotus,* occur in the lower Magdalena Valley in Colombia, and *remotus,* like several other northern Colombian dragonflies, is found also in Central America, in this particular case in Panama and Costa Rica. It seems clear that Group I has penetrated to the north over two routes, one by

the Rio Negro and the Magdalena, the other probably by way of the Rio Branco and Guianan rivers. At least the southern tributaries of the Orinoco should yield some species of Perilestes but at present none is known from Venezuela.

The southern Group II has its headquarters in the Amazonian basin. It is probably older and is certainly not as homogeneous as Group I. One very distinct species, *fragilis*, which about equals in size the larger species, *remotus* and *magdalenae* of Group I, is, like these two species, the most widely separated from the Amazonian basin, being known only from the vicinity of Rio Janeiro. Its nearest rival in size in its group is *kahli*, probably its nearest relative, also a very distinct species, and also one on the fringe of the geographical distribution of the group, being known only from the Madeira River in Matto Grosso, and from the Rio Japacani in eastern Bolivia. Another very distinct species of the group is *attenuatus*. In fact, as regards probable relationship with other species of the group, it is the most distinct of all. It has a wide distribution, occurring on the Rio Beni in Bolivia, on the Madeira at Porto Velho, Amazonas, on the Rio Negro at Manáos, and on the lower Amazon at Santarem. The two remaining species of the group, *solutus* and *minor*, are closely related. *Solutus* occurs on the Madeira River in Matto Grosso, and its range extends southward into the Paraguay in the same state. It is also probably along the entire lower Amazon as it has been taken at Pará. *Minor* is the smallest species of the genus and is known only from the Madeira River at Porto Velho, Amazonas.

Habits

All Perilestes are forest stream dwellers. The small creeks where we have invariably found them may be briefly described. The three streams at Cristalina, Colombia, have been described in Misc. Publ. No. 30, Univ. of Mich., Mus. of Zool. To briefly summarize this description, the creeks flow in a rolling or hilly, heavily forested country at an elevation of about 320 meters. They vary in size from a few inches to ten or twelve feet in width. Generally the flow is gentle, pools alternating with short ripples. The beds are mixed mud and gravel. The flora is rich with overhanging bushes and clumps or stretches of aquatics. When we collected there the streams were at low water stage and the water was clear. This description will do equally well for the two streams in the Canal Zone, Panama, where we found Perilestes. In Brazil, similar streams were found at Porto Velho (60 meters above sea level), Albuná, Villa Murtinho, Manàos and Pará, each inhabited by from one to three species of Perilestes. The streams near Cashuelo Esperanza, Bolivia, contained a few outcroppings of rock but otherwise fell within the general description given above. On Mt. Tijuca, in the vicinity of Alto Boa Vista, a suburb of Rio de Janeiro, there are several creeks about one foot deep, varying in width from eight to twenty feet and having a rapid descent among boulders and outcroppings of solid rocks. Perilestes was found in limited numbers along the wooded portion of these creeks.

On the position at rest and in flight, we made the following note on *remotus* at Cristalina. In so far as we did not in the field recognize *magdalenae* as distinct it is probable the note will apply equally well to both species. "Rest with abdomen hanging, wings half spread, and with the last four abdominal segments often curled up over the back. Flight swift, abdomen 'dragging'." And at the same locality on February 14, we noted of both sexes: "Flies till at least 4:30 P. M., when the ravine is dark and gloomy. Always rests with the abdomen hanging but the flight is strong. Males frequently hover head on just as Heteragrion does. At rest they are easily caught in the fingers." Of *attenuatus*, J. H. W. noted, "First male seen (at Abunà) hanging with folded wings from tip of leaf eight feet above the ground; the second was flying in the woods a few inches above the ground."

On pairing habits we have the following note on *remotus*, made at Cristalina: "Female hung from vine; male alighted on the apex of her abdomen and walked up to her head which he held by his feet while he fastened his appendages. He then filled his seminal vesicle, kicking the female vigorously about the head with his hind legs while doing so. Copulation followed immediately, and then the seminal vesicle was filled again, with more kicking." And at Villa Murtinho, J. H. W. noted of *solutus*: "Saw a female resting on an almost horizontal twig. A male came up from below and grasped her, she apparently aiding by using front legs. They then flew to a perpendicular twig about a foot away and the tip of the male's abdomen was brought for an instant into contact with his genitalia. Female then brought the tip of her abdomen to genitalia. After a second or two the sun was clouded and I captured the pair by catching the male by the wings, in my fingers."

SOURCES OF MATERIAL AND METHODS OF STUDY

We are indebted to Mr. Morton and Mr. Kahl for the privilege of studying certain specimens as indicated under each species in the material studied. The bulk of the material available to us, representing by far the larger number of all known specimens, has resulted from two of our collecting trips. Of first importance is the Brazilian collection made by J. H. Williamson and John W. Strohm, in 1922. The other trip which resulted in considerable material in this genus was the University of Michigan-Williamson Expedition to Colombia. We failed to find Perilestes on our trips to British Guiana, Trinidad, Venezuela and Peru. This was especially surprising to us in Venezuela, but the suitable streams (as we understand them) which we collected in Venezuela were on the north side of the mountains. Evidently the Magdalena species, doubtless derived from the Amazonian headquarters, have been able to work northward into Central America, but have not spread eastward across the Maracaibo region into the Venezuelan streams flowing into the Caribbean.

In this paper, in the section *Generic and Specific Characters*, we have explained the method followed in counting the wing cells, posterior to Cu_2.

Sometimes the first cross-vein normally crossing Cu_2 stops at Cu_2 and does not reach the hind margin. In such a case the basal cell posterior to Cu_2 is the equivalent of two cells, and in counting cells posterior to Cu_2 this basal peculiarity reduces the number of cells by one, but has nothing to do with the length or distal termination of Cu_2, thus introducing a misleading factor in the description of Cu_2.

All measurements in this paper are in millimeters. Length of abdomen includes the appendages. The color descriptions of preserved specimens, because of indefinite patterns and obscure markings, are not very satisfactory and there is a possibility that they give a very imperfect picture of the living insects. However our brief color notes, made from fresh material, while certainly less complete than we now wish, indicate no particularly striking differences between the living and preserved individuals. Probably even in life, color patterns are obscure and indefinite, and detailed descriptions would be difficult, tedious and more or less incomprehensible. It is not impossible that some delicate and evanescent colors, overlooked by us in our hurried note making of freshly caught specimens, may be detected in the future by more leisurely and better equipped students. It must be remembered also that an obscure or indefinite color pattern may, by a slight increase of pigment, become sharp and definite and that such increase of pigment may take place nearly at the end of imaginal life and after sexual maturity has been attained. Abdominal appendages of both sexes are measured in dorsal view from apex of dorsum of segment 10 to apex of appendages. The anterior lamina is measured from the apex of the sternum of segment 1 to the apex of the posterior process. Possibly better fixed points might be selected, as a bending of the abdomen between segments 1 and 2, either dorsally or ventrally, moves the basal point. But in measuring the length of the expanded postero-ventral wing of the tergum of 2, and the distance from its apex to the base of the segment, while the antero-ventral angle of the tergum is theoretically an admirable fixed point, in actual practice it was found that due to bending of the abdomen this angle was often concealed. The valve is measured from the posterior angle of the basal plate of the ovipositor to the apex of the valve. The form of the hind border of the prothorax is described as seen in antero-dorsal view. And similarly the mesostigmal lamina is described as seen in postero-dorsal view.

Key to Groups and Species of Perilestes

1. M_{1a} arising usually at the level of one cell before the stigma or more proximad. Abdominal segments 3–6 each with a pale postbasal ring or area proximal to an extensive dark median area. Face similar in the two sexes, dark to black, not sharply patterned, the anteclypeus if paler only slightly so and not strikingly different from the labrum and postclypeus. Male superior appendage with a basal dilatation ending on the inner border in an acute spine. Blade of the second hamule slender, narrowly spoon-shaped or tapering, if flattened the apical blade with its flat surface in the line of the long axis of the abdomen; anterior lamina longer (1.5 or more), slenderer,

usually largely dark colored. Adult male with metasternum and femora largely or entirely black (except in *guianensis* as shown by scanty material). Adult male with sterna of 9–10 yellowish or blue (except *cornutus* which has sterna of 8–10 yellow or blue) ..... Group 1. Males 2. Females 5.

1′. M_{1a} arising usually at the level of the proximal end of stigma or more distad. Abdominal segments 3–6 each with a pale basal ring, the dark area following it continuous with the dark median area. Face dissimilar in the two sexes, in the male sharply patterned black and bright pale blue, in the female less distinctly patterned, no bright blue, duller, the black or dull labrum with pale basal areas or darker edged. Male superior appendage without a basal dilatation, or, if present, with it ending on the inner border in a tongue-like plate with a rounded apex. Blade of the second hamule wider, very broadly spoon-shaped or angled in cross-section, the flat or external surface transverse to the long axis of the abdomen; anterior lamina shorter (less than 1.5), largely pale colored. Adult male with metasternum and femora not largely or entirely black. Adult male with sterna of 8–10 bright blue (or possibly bright yellow in *fragilis*) ..... Group II. 8.

2 (1). Stigma reddish brown; spine of superior appendage small, placed slightly distad to midlength of the appendage and directed caudo-ventrad ..... *cornutus*

2′. Stigma black ..... 3.

3 (2′). Metasternum and femora largely pale; spine of superior appendage large, placed at about midlength of the appendage, directed ventrad and only slightly caudad ..... *guianensis*

3′. Metasternum and femora largely black ..... 4.

4 (3′). Anal plate a small but conspicuous cordate tubercle projecting beyond the apex of segment 10 in dorsal view; spine on superior appendage basal to midlength of the appendage and directed caudad ..... *remotus*

4′. Anal plate inconspicuous, a small rounded tubercle concealed within the apex of segment 10 in dorsal view; spine on superior appendage distal to midlength of appendage and directed more ventrad than caudad ..... *magdalenae*

5 (1). Hind lobe of prothorax bearing an erect median spine ..... 6.

5′. Hind lobe of prothorax not spined; stigma black ..... 7.

6 (5). Stigma reddish brown ..... *cornutus*

6′. Stigma black; point of attachment of valvular styles under the abdominal appendages ..... *magdalenae*

7 (5′). Point of attachment of valvular styles under the abdominal appendages ..... *guianensis.*

7′. Point of attachment of valvular styles distal to the level of the apices of the abdominal appendages ..... *remotus*

8 (1′). Six or fewer cells behind Cu_2 in the hind wing; stigma black or brown (but not reddish brown). Male appendage without spine or plate in the basal half, distal to midlength a biparted spoon-like dilatation on the inner edge, about equal in length to the narrowed apex; male labrum and anteclypeus bright light blue, almost white, the former black-bordered in front, postclypeus shining greenish black. Female with point of attachment of valvular styles about the level of the apices of the abdominal appendages; hind border of the prothorax straightened, nearly horizontal, dropping off at either end with a nearly vertical lateral margin; mesostigmal lamina low, of uniform heighth ..... *attenuatus*

8′. More than six cells behind Cu_2 in the hind wing

Males 9. Females 12 (female of *minor* not known).

9 (8′). Male appendage with only an angle on the inner edge at about two-sevenths the length; apex of dorsum of segment 10 slightly elevated in the middorsal line and concave on either side of this and dorsal to the appendages; dorsum of segments 8–10 black, 8 with about the basal third pale (yellow or blue); stigma reddish brown ..... *kahli*

9′. Male appendage with a flattened tongue-like blade or lobe on the inner edge at about one-third the length; apex of dorsum of segment 10 not elevated but low and flat; dorsum of segments 8–10 dark but not all distinctly black, the pale basal area on 8 reduced to less than one-third the segment ..... 10.

10 (9′). Stigma reddish brown; labrum very narrowly black edged; outer end of mesostigmal lamina ending in a laterally directed free, acute point ..... *solutus*

10′. Stigma black; labrum with more black than in *solutus*; mesostigmal lamina not ending in a free, acute point ..... 11.

11 (10′). Labrum with less than the anterior half black ..... *fragilis*

11′. Labrum largely black ..... *minor*

12 (8′). Stigma reddish brown; outer end of mesostigmal lamina angular or a free point ..... 13.

12′. Stigma black; outer end of mesostigmal lamina scarcely or not elevated but low and rounded; valvular styles at their origin proximal to the level of the apex of 10; dorsum of 9 largely dull brown, shading imperceptibly into the pale lateral basal area on either side ..... *fragilis*

13 (12). Dorsum 8–10 black; a large distinct pale lateral basal area on either side of 9 ..... *kahli*

13′. Dorsum of 8–10 brown; pale, lateral basal areas on 9 reduced, more widely separated by the dorsal brown, less sharply outlined ..... *solutus*

Descriptions of Species

1. *Perilestes cornutus* Selys

Abdomen male 46–50.5; hind wing male 22.5–25; stigma front wing male 1.20–1.47; stigma hind wing male 1.27–1.50; abdominal appendage male 1.40; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 2.1.

Male.—Head similar to that of *remotus*; the labium with a brown area on the suture between the mentum and submentum.

Prothorax similar to that of *remotus*, the proepimeron dark to black and this dark area extended broadly onto the proepisternum; hind border semicircular.

Thorax similar to that of *remotus*, the dark colors possibly duller, dark brown instead of black over much of the dark areas of the mesothorax; the pale area of the metepisternum more nearly reaches the wing base above.

Mesostigmal lamina elevated from either extremity, in nearly straight edges, to a low but distinct obtuse angle placed nearer the lower extremity.

Coxae similar to those of *remotus*. Femora black, more or less pale on the anterior face, especially just before the apex. Tibiae pale to obscure, the first and second sometimes largely darker to black above, with less dark beneath, the third with little or no dark.

Venation as in *remotus*; stigma reddish brown.

Abdomen seen from above: 1 pale with obscure and indefinitely patterned median brown from base to apex, darkest at apex; 2 similar to that of *remotus* but the median longitudinal pale stripe duller, not as sharply patterned; 3 as in *remotus* but the postbasal pale area more or less reduced; 4–6 as in *remotus,* but the anteapical pale area of 6 is discernible in *cornutus,* and the pale postbasal area of the same segment is less extensive; 7 brown, slightly and indefinitely paler postbasally; 8 brown, the apical half or two-thirds indistinctly darker; 9 nearly black; 10 black. Seen from the side similar to that of *remotus* but on 3–6 the postbasal pale area is slightly reduced as compared with *remotus* and on 3 the sternum, opposite the median dark area, is pale, not dark as it is in *remotus*; 7 with the postbasal pale area more extensive in *cornutus* than in *remotus* and with traces of the same area on 8 in *cornutus*; anterior lamina and posterior processes of 2 largely dark; lateral color pattern of 4–6 carried across the sterna; sternum of 7 largely dark, the basal fifth, or slightly more, pale; sterna of 8–10 bright pale colored, yellow (?) or more probably blue (?) in life. Appendages largely dark colored, black along the outer edge, shading out to brown on the inner edge and on the extreme base and apex; on the dorsal surface just basal to the spine is a smooth shallow elliptical depression which is nearly or quite white (possibly bright blue in life).

Length of the wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .7, and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 2.2.

Venational characters based on four males

Postnodals front wing, 13 (25%), 14 (25%), or 15 (50%); hind wing, 11 (12.5%), 12 (12.5%), 13 (62.5%), or 14 (12.5%).

M_3 in front wing arising between the first and second postnodals (100%); in the hind wing at the first postnodal (50%), or between the first and second postnodals (50%).

Rs in front wing arising at the seventh postnodal (37.5%), or at the eighth postnodal (62.5%); in the hind wing at the sixth postnodal (12.5%), at the seventh postnodal (62.5%), or at the eighth postnodal (25%).

M_2 in front wing arising at or near the eighth postnodal (37.5%), or at or near the ninth postnodal (62.5%); in the hind wing at or near the seventh postnodal (37.5%), or at or near the eighth postnodal (62.5%).

M_{1a} in front wing arising three cells before the stigma (75%), or four cells before the stigma (25%); in the hind wing two cells before the stigma (12.5%), or three cells before the stigma (87.5%).

Number of cells posterior to Cu_2 in front wing, 13 (37.5%), 14 (37.5%), 15 (12.5%), or 16 (12.5%); in hind wing, 9 (25%), 10 (12.5%), 12 (25%), 13 (12.5%), 14 (12.5%), or 15 (12.5%).

Material examined: *Brazil,* Porto Velho, Amazonas, May 2 and 24, 1922, 5 males; Villa Murtinho, Matto Grosso, April 4, 1922, 2 males; all in coll. E. B. W.

This species was associated with *solutus* and *kahli* at Villa Murtinho and with *attenuatus* at Porto Velho. Unfortunately no females were taken and our knowledge of this sex is based on De Selys' description. As to the correctness of our determination of the seven males before us as *cornutus* there can be little or no doubt. De Selys' description of the male clearly indicates the group of the genus to which our specimens belong (origin of M_{1a} and spine on the superior appendage). No other species of the group is known in the Amazon basin, and the color of the stigma and detailed description of the superior appendages agree with our specimens. There is no reason to doubt that the female (or females) described by De Selys belonged to the same species as his male.

2. Perilestes guianensis, new species

Abdomen male 44–46, female 39–42; hind wing male 21.5–23, female 24–25; stigma front wing male 1.13–1.20, female 1.24–1.35; stigma hind wing male 1.30–1.33, female 1.40–1.50; abdominal appendage male 1.30, female .40; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.6–1.7; female valve 2.3.

Male.—Labium as in *remotus*; labrum, clypeus and frons brown, the labrum sometimes narrowly darker along its base, anteclypeus largely darker with some greenish, postclypeus darker medianally and anteriorly, and frons darker at the extreme lateral margins.

Prothorax obscure, sides pale, dorsum darker, especially on the hind lobe; the proepimeron largely and the proepisternum to a lesser extent, dark; hind border semicircular.

Thorax similar to that of *remotus* but reddish brown largely or entirely replacing the black of the latter species, except in the second lateral suture, and with the following differences: the pale color on the metepisternum above and anteriorly nearly or quite reaching the wing base; the metepimeron is entirely pale, the black stripe on the second lateral suture confined to the metepisternum and continued below across the upper edge of the metinfraepisternum, thus resembling *magdalenae* but more reduced even than in that species; no black on the latero-ventral carina and the merest trace of dark on the metepimeron. Beneath pale, the sterna black.

Mesostigmal lamina low, very slightly elevated at the point where the angle occurs in that of *cornutus*.

Coxae pale, unmarked. Femora pale, each slightly darker at apex and with a more or less distinct postbasal dark ring and a very slightly more extensive anteapical one, the two rings more or less joined along the anterior row of spines. Tibiae pale.

Venation similar to that of *remotus*.

Abdomen seen from above: 1 pale, brown ringed apically; 2–6 similar to those of *remotus*, the brown on 2 paler, duller and reduced; 7 with an ill or well defined, dull and pale postbasal area following the slightly darker and more reduced basal brown, the median brown area into which the postbasal pale area darkens is followed or not by an ill defined, scarcely

distinguishable anteapical pale area, the apex is darker brown to black; 8 shading from brown at base to nearly black at the apex; or largely brown throughout; 9 similar to 8 but darker; 10 black, or 9 and 10 brown. Seen from the side 1–6 similar to those of *remotus* but the basal inferior spot on 2 wanting or very small; 7–9 largely pale, each more or less darker at apex and along the ventral border; 10 black or brown. Sternum of 1 pale; anterior lamina pale, the posterior processes darkening to brown with the ventral edge of the plate black; 3–6 each with the lateral color pattern carried across the sternum; sternum of 7 largely dark to black; 8 black with a median pale area nearer base than apex; 9 and 10 pale (blue? in life), the latter discolored by postmortem changes. Appendages pale dull yellow to brownish horn color, slightly darker at base.

Length of the wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .6, and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 1.8.

Female.—Head similar to that of the male.

Prothorax, thorax, mesostigmal lamina, coxae, legs, venation and stigma similar to those of the male.

Abdominal segments 1–7 similar to those of the male; seen from above 8 and 10 are black or nearly so, and 9 is about as in *remotus* with the dark bar slightly narrower in the basal two-thirds; seen from the side 8 and 10 are brown, and 9 is largely blue, shading apically into the brown of the apically widened dorsal band, with the blue and brown shading below into black along the entire ventral border. Sternum of 1 and 2 pale, the latter with or without a trace of dark at midlength; 3–6 with the lateral color pattern of each carried across the sternum; sternum of 7 largely dark, pale for a short distance at the base; of 8 largely pale (blue? in life), an irregular dark median area beginning before the middle and extending to the apex. Appendages brown, shaped as in *magdalenae*. The valvular styles with points of attachment under the appendages.

Venational characters based on three males and four females

Postnodals front wing, 13 (12.5% female), 14 (50% males, 50% females), or 15 (50% males, 37.5% females); hind wing, 11 (33.3% males), 12 (33.3% males, 62.5% females), or 13 (33.3% males, 37.5% females).

M_3 in front wing arising between the first and second postnodals (100% males, 100% females); in the hind wing at the first postnodal (66.7% males, 62.5% females), or between the first and second postnodals (33.3% males, 37.5% females).

Rs in front wing arising at the sixth postnodal (12.5% females), at the seventh postnodal (50% males, 50% females), or at the eighth postnodal (50% males, 37.5% females); in the hind wing at the sixth postnodal (66.7% males, 62.5% females), or at the seventh postnodal (33.3% males, 37.5% females).

M_2 in front wing arising at or near the seventh postnodal (12.5% females), at or near the eighth postnodal (33.3% males, 37.5% females), or

at or near the ninth postnodal (66.7% males, 50% females); in the hind wing at or near the sixth postnodal (16.7% males), at or near the seventh postnodal (16.7% males, 75% females), or at or near the eighth postnodal (66.7% males, 25% females).

M_{1a} in front wing arising three cells before the stigma (83.3% males, 75% females), four cells before the stigma (16.7% males, 12.5% females), or five cells before the stigma (12.5% females); in the hind wing two cells before the stigma (50% males), three cells before the stigma (50% males, 62.5% females), or four cells before the stigma (37.5% females).

Number of cells posterior to Cu_2 in front wing, 13 (16.7% males), 14 (33.3% males, 12.5% females), 15 (50% males, 75% females), or 16 (12.5% males); in hind wing, 11 (16.7% males), 12 (50% males, 12.5% females), 13 (16.7% males, 37.5% females), 14 (25% females), 15 (16.7% males), or 16 (25% females).

Material examined: *French Guiana*, Pied Saut, Oyapok River, November, 1917, S. M. Klages, Carn. Mus. Acc. 6111, 1 male, 3 females, the male the type and one female the allotype; Tamanoir, Mana River, June, 1917, S. M. Klages, Carn. Mus., 1 male; St. Laurent du Maroni, coll. K. J. Morton, 1 male, 1 female.

None of the above material is perfect and all appear somewhat teneral or discolored. It is therefore probable that the color description will be found to be inaccurate for mature and well preserved or freshly killed specimens. At the same time the structures are well enough preserved in the material available for this paper and there should be no trouble in the future in recognizing the species.

Hagen describes *fragilis* from two females, a larger from Congonhas, Brazil, and a smaller from the Essequibo, British Guiana. The larger Brazilian specimen evidently served largely, if not entirely, as the basis of both the generic and specific descriptions. His generic description will apply probably only to Group II, as defined in the synoptic key in this paper. Our material from the Guianas is very incomplete, but there is no reason to think Hagen's two females are conspecific and it seems better to retain the name *fragilis* for the southern Brazilian species to which Hagen's description better applies, and which is therefore the type of the genus, and to give a new name to the only species certainly known from the Guianas. This species, *guianensis*, belongs to our Group I, and its nearest relative is probably *magdalenae* from the lower Magdalena in Colombia.

3. **Perilestes remotus**, new species

Abdomen male 50–54, female 41.5–43.5; hind wing male 23.5–25.5, female 25–26; stigma front wing male 1.05–1.10, female 1.10–1.30; stigma hind wing male 1.20–1.30, female 1.27–1.40; abdominal appendage male 1.40, female .40–.46; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.8–2.0; female valve 3.0.

Male.—Labium pale, apices of median lobe, end hook and movable hook

shaded darker; labrum and postclypeus black, the anteclypeus paler, dull greenish or brown, the labrum sometimes with more or less brown.

Prothorax brown above, narrowly on the front lobe, the sides pale, proepimeron largely brown; hind border shallowly trilobed.

Thorax above black, middorsal carina very narrowly brown, a narrow pale greenish or yellowish antehumeral stripe, not reaching the antealar sinus above, and projected across the prothorax below, about .3 wide at the widest part; mesepimeron largely black, the same broad band of color carried across the mesinfraepisternum; metepisternum largely pale yellowish or flesh colored except above where a broad black band on the second lateral suture crosses it to join the black on the mesepimeron; metepimeron pale colored like the metepisternum except where the pale area is encroached on by the broad black band on the second lateral suture, a limited area of dark to black above and below, and a narrow edge of black on the latero-ventral carina posterior to its angle; the black stripe on the second lateral suture is carried across the metinfraepisternum leaving only its lower angle pale. Metasternum black.

Mesostigmal lamina elevated into a low lobe just external to the end of the fork of the middorsal carina; below (external to) this lobe the lamina is low and nearly symmetrically convex.

Coxae pale, marked with dark to black; on the anterior face the first coxa has a mere trace of dark, the second nearly the inner half dark, and the third all dark but a narrow outer border; the posterior face of each coxa darker than the anterior face, and again the first is the palest and the third the darkest. Femora black, the last two and rarely the first each with an anteapical anterior pale spot. Tibiae black with the anterior surface pale.

Venation black, main veins shading out, especially on the ventral surface, to nearly white at base; stigma black, brown (but not reddish brown) in tenerals.

Abdomen seen from above: segment 1 pale, a more or less distinct narrow longitudinal middorsal stripe and an apical ring, brown; 2 dark brown except at base and a longitudinal middorsal pale stripe, not reaching the apex; 3 with base pale, followed by a slightly darker area, followed by a slightly more extensive pale area, which darkens posteriorly into a dark area nearly or quite black at its middle, which occupies about one-third or slightly less of the segment, and which fades out posteriorly into a pale area about equal in extent to the pale area which bounds it anteriorly; this pale area darkens posteriorly into a more extensive black area which reaches to the apex; 4–6 similar to 3 but the pale basal area (a smooth area lacking minute transverse striae) is scarcely paler than the dark area which follows it, the large median dark area is relatively more extensive and the anteapical pale area which separates it from the apical black is progressively reduced from 4 until it has quite disappeared on 6; the postbasal pale area is about the same extent on each of segments 3–6; 7–10 black. Seen from the side: 1 pale except at apex; 2 pale below except a basal spot at the inferior border; 3–6 as in dorsal view, except the post-

basal pale area on each is more extensive along the ventral border than in the middorsal line, and it is a conspicuous lateral spot on 7 on which segment it is not visible in dorsal view; 8–10 black, the apical ventral angle of 10 pale. Sternum of 1 largely or entirely dark; anterior lamina and posterior processes of 2 largely dark; lateral color pattern of 3–7 carried across the sterna; sternum of 8 largely dark, pale basally and apically; sterna of 9 and 10 bright pale colored, yellow (?) or more probably blue (?) in life. Appendages nearly white to pale reddish horn color.

Length of the wing on lobe on the expanded postero-ventral margin of the tergum of 2 about .6, and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 2.0.

Female.—Head similar to that of the male.

Prothorax dull pale color without definite or extensive markings, the dorsum of the two posterior lobes dusky, proepimeron largely dusky to brown; hind lobe as in the male.

Thorax patterned similarly to that of the male, but the black is replaced by dark reddish brown except a narrow black border to the pale middorsal stripe, part of the extreme lower end of the broad stripe which covers the mesepimeron, and the broad stripe on and just anterior to the second lateral suture which remains distinctly and conspicuously black; there is a mere line of black above on the metepimeron and none at all on the latero-ventral carina. Metasternum pale, an indefinite trace of brown basally in the median line.

Mesostigmal lamina similar to that of the male.

Coxae pale, a small dark area on the anterior face of the third. Femora largely pale, obscurely darker above, black beneath and at the apex. Tibiae pale, a narrow dark streak beneath, and the first tibia narrowly dark streaked above.

Venation and stigma similar to those of the male.

Abdominal segments 1–5 colored about as in the male; in 6 the dark median area is not black in its darkest portion and it fades out posteriorly into a light reddish brown area which passes into darker apical brown, but not black; similarly 7 and 8 are reddish brown, instead of black as in the male, though there is an indefinite trace of black in the middorsal line of 8; 9 with a dorsal longitudinal ill defined dark bar about .8 wide at base, bounded on either side basally with blue for about two-thirds its length, widening apically and becoming paler below in its apical third till it fades out with the lateral basal blue spot in a general loss of color pattern along the ventral border, 10 black or nearly so. Sternum of 1 pale, of 2 largely dark, of 8 largely blue, apparently the same color in life as the large lateral basal spot on 9. Appendages dark brown, black at apex, flattened cone-shaped, acute. Valves long, the valvular styles at their point of attachment distal to the apices of the appendages.

Venational characters based on four males and four females

Postnodals front wing, 13 (12.5% males), 14 (25% males, 25% females),

15 (50% males, 12.5% females), 16 (12.5% males, 50% females), or 17 (12.5% females); hind wing, 12 (25% males, 25% females), 13 (50% males, 12.5% females), or 14 (25% males, 62.5% females).

M_3 in front wing arising at the first postnodal (12.5% males), or between the first and second postnodals (87.5% males, 100% females); in the hind wing at the first postnodal (37.5% males) or between the first and second postnodals (62.5% males, 100% females).

Rs in front wing arising at the seventh postnodal (50% males, 62.5% females), or at the eighth postnodal (50% males, 37.5% females); in the hind wing at the sixth postnodal (25% males, 12.5% females), at the seventh postnodal (62.5% males, 87.5% females), or at the eighth postnodal (12.5% males).

M_2 in front wing arising at or near the seventh postnodal, (12.5% males), at or near the eighth postnodal (50% males, 37.5% females), at or near the ninth postnodal (25% males, 62.5% females), or at or near the tenth postnodal (12.5% males); in the hind wing at or near the seventh postnodal (50% males, 25% females) or at or near the eighth postnodal (50% males, 75% females).

M_{1a} in front wing arising three cells before the stigma (62.5% males, 37.5% females), four cells before the stigma (25% males, 62.5% females), or five cells before the stigma (12.5% males); in the hind wing two cells before the stigma (25% males), three cells before the stigma (62.5% males, 50% females), or four cells before the stigma (12.5% males, 50% females).

Number of cells posterior to Cu_2 in front wing, 14 (25% females), 15 (12.5% males), 16 (50% males, 25% females), or 17 (37.5% males, 50% females); in hind wing, 12 (12.5% males, 12.5% females), 13 (50% females), 14 (75% males, 37.5% females), or 15 (12.5% males).

The following brief color note was made on a male taken at Cristalina: eyes above dark green, lighter below, light thoracic markings very pale greenish yellow, almost white. Teneral specimens are entirely without black, being dull brown with obscure paler markings. Probably all degrees of color between this dull brown and the clear bright black of the fully adult specimens are passed in the life period. Specimens otherwise apparently mature have been noted with traces of brown in the labrum and with the black of the mesepimeron duller above, shading out into brown.

Material examined: *Canal Zone,* Panama, Rio Sardanilla, December 5, 1916, 1 male, 1 female, both tenerals; Rio Mazamba, December 6, 1916, four males, all tenerals; *Colombia,* Cristalina, Dept. Antioquia, Quebradas Cristalina (73 specimens), Sabaleticus (44 specimens), and La Camelia (6 specimens), February 12–19, 1917, 116 males, 7 females, type male Quebrada Cristalina, February 12, allotype female Quebrada Sabaleticus, February 14, all in coll. E. B. W.

This is the only species of Perilestes which has reached Central America. At Cristalina, Colombia, it was associated with the much rarer *magdalenae.*

4. **Perilestes magdalenae,** new species

Abdomen male 49–52.5, female 46; hind wing male 23.5–25, female 26–27;

stigma front wing male 1.07–1.20, female 1.27–1.40; stigma hind wing male 1.27–1.40, female 1.47–1.50; abdominal appendage male 1.5–1.6, female .35–.40; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.55–1.60; female valve 2.14–2.26.

Male.—Head similar to that of *remotus*.

Prothorax similar to that of *remotus,* but slightly paler, the hind border straighter, the median and lateral lobes less evident.

Thorax similar to that of *remotus* but duller; mesepimeron largely brown instead of black; the black stripe on the second lateral suture is slightly narrower and at the metinfraepisternum it is not joined across the metepimeron with the ventral black as it is in *remotus*. Metasternum black as in *remotus,* but with a pale median longitudinal area of variable width from the level of the angle of the latero-ventral carinae to near the apex of the metasternum.

Mesostigmal lamina low, nearly straight, a short shallow concavity just before its lower end.

Coxae pale, a triangular dark area on the anterior face of the third, and the posterior face of the second and third largely dark. Femora black but with the anteapical pale spot of *remotus* enlarged to an anterior pale stripe on each femur from the coxa quite to or near the apex. Tibiae as in *remotus*.

Venation and stigma as in *remotus*.

Abdomen seen from above: 1 with a large squarish median basal brown spot reaching about two-thirds the length of the segment, narrowly separated from an apical brown area which joins the apical ring of dark brown or black; 2–6 about like 2–6 in *remotus,* but the paler area on each segment, except the postbasal, is slightly more extensive on 3–6 in *magdalenae*; the postbasal pale areas on 7 are more nearly joined in the median line in *magdalenae* so that 7 is about the same pattern in *magdalenae* as 6 is in *remotus*; 8–10 black. Seen from the side: 1–7 as in *remotus,* but the basal ventral spot on 2 is reduced to an inconspicuous small brown area in *magdalenae* and the pale areas, except the postbasal pale areas, are more extensive in *magdalenae*; 8–10 as in *remotus*. Sternum of 1 pale, brown at base, shading out into the pale color about midlength of the sternum; anterior lamina as in *remotus*; lateral pattern of 3–7 carried across the sterna; 8–10 and color of appendages as in *remotus*.

Length of the wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .7 and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 1.9.

Female.—Head similar to that of the male.

Prothorax largely pale, a longitudinal median pale brown stripe and procpimeron largely brown; dorsum of hind lobe, against the posterior border, elevated into an erect, acute, median spine about .5 long; lateral margin of hind border rather prominent, the supero-lateral angle about 90°.

Thorax similar in color pattern to that of the male, but the black is replaced by dark reddish brown except a narrow black border to the pale middorsal stripe, and the stripe on the second lateral suture which re-

mains distinctly and conspicuously black; ventro-lateral carina and metasternum entirely pale except for the merest trace of a brown line on the median suture from the third coxae to the level of the angle of the latero-ventral carinae.

Mesostigmal lamina low, the edge nearly uniformly curved.

Coxae pale, a small dark area on the anterior face of the third. Femora largely pale, obscurely darker above, black beneath and at the apex. Tibiae pale, the first tibia narrowly dark streaked above and all dark streaked beneath.

Venation and stigma similar to those of the male.

Abdominal segments 1–6 patterned about as in the male but with the median dark area of 4–6 paler, darkest immediately following the postbasal pale area, on 6 scarcely darker than the anteapical pale area; the postbasal pale area on 4–7 is slightly reduced in area in its dorsal but not in its lower ventral part as compared with the male and the apical dark area grows progressively paler posteriorly so it is brown instead of black on 6; 7 reddish brown, the postbasal pale areas widely separated in the median line; 8–10 black above, on 9 reduced to a well-defined median longitudinal bar about .8 wide basally which widens laterally, at about two-thirds the length of the segment, and passes into brown on the sides, terminating at the apex at about midheighth of the segment; this black bar is bounded basally on either side by a large blue sharply defined lateral spot; sides of 9 largely blue, the ventral border at midlength narrowly black, from which point the ventral black widens in both directions to base and apex giving a circular form to the lower edge of the lateral blue spot. Sternum of 1 largely pale, of 2 largely black, of 8 largely pale (blue? in life). Appendages pale brown, black at extreme apex, flattened cone-shaped, acute; as compared with those of *remotus* they are less tapering in the apical two-thirds or three-fourths and less acute,—evident differences when direct comparisons are made but difficult to describe. Valvular styles at their point of attachment about at the level of the apex of 10.

Venational characters based on four males and two females

Postnodals front wing, 13 (50% males, 25% females), 14 (50% males, 25% females), 15 (25% females), or 16 (25% females); hind wing, 10 (12.5% males), 11 (37.5% males), 12 (37.5% males), 13 (12.5% males, 75% females), or 14 (25% females).

M_3 in both front and hind wings arising between the first and second postnodals (100% males, 100% females).

Rs in front wing arising at the seventh postnodal (75% males, 25% females), or at the eighth postnodal (25% males, 75% females); in the hind wing at the sixth postnodal (37.5% males), at the seventh postnodal (62.5% males, 75% females), or at the eighth postnodal (25% females).

M_2 in front wing arising at or near the seventh postnodal (12.5% males), at or near the eighth postnodal (62.5% males), at or near the ninth postnodal (25% males, 75% females), or at or near the tenth postnodal (25% females); in the hind wing at or near the seventh postnodal (75% males),

at or near the eighth postnodal (25% males, 75% females), or at or near the ninth postnodal (25% females).

M_{1a} in front wing arising at the proximal end of the stigma (12.5% males), two cells before the stigma (62.5% males, 100% females), or three cells before the stigma (25% males); in the hind wing one cell before the stigma (37.5% males), two cells before the stigma (62.5% males, 75% females), or three cells before the stigma (25% females).

Number of cells posterior to Cu_2 in front wing, 11 (25% males), 13 (50% males), 14 (12.5% males, 50% females), or 15 (12.5% males, 50% females); in hind wing, 9 (12.5% males), 10 (75% males, 25% females), 11 (12.5% males, 50% females), or 12 (25% females).

At the time of capture *magdalenae* and *remotus* were not recognized as two species, and all our notes are on envelopes containing the much commoner species, *remotus*.

Material examined: *Colombia,* Cristalina, Dept. Antioquia, Quebradas Cristalina (3 specimens), Sabaleticus (3 specimens) and La Camelia (4 specimens), February 12–18, 1917, 8 males, 2 females, type male Quebrada La Camelia, February 18, allotype female Quebrada Cristalina, February 12; all in coll. E. B. W.

This species is known only from the streams about Cristalina, Colombia, in the Magdalena Valley, where it was associated with the commoner *remotus*.

5. *Perilestes attenuatus* Selys

Abdomen male 43.5–48, female 37–37.5; hind wing male 20–21.5, female 20.5–22; stigma front wing male 1.05–1.10, female 1.10–1.20; stigma hind wing male 1.15–1.20, female 1.20–1.27; abdominal appendage male 1.40–1.60, female .30–.35; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.30–1.40; female valve 1.95–2.20.

Male.—Labium pale, apices of parts very slightly darker, except the movable hook which has the apical half or more black as in *kahli*; labrum and clypeus in front light blue, almost white, the former in front with a straight black border, occupying scarcely one-fourth the length of the labrum, clypeus above black, the line between the black and pale areas smooth.

Prothorax pale, slightly darker above, especially posteriorly where it is pale reddish or rusty brown; hind border straightened above, very slightly trilobed, the lateral extremities almost vertical.

Thorax above like that of *kahli* except that the antehumeral pale stripe reaches the upper end of the mesepisternum; side of thorax similar to that of *fragilis* except that the dark stripe on the second lateral suture is slightly wider throughout and widens below on the metepimeron into a more or less bilobed expansion; metinfraepisternum dark reddish brown above, shading into black below, the lower angle pale. Metasternum pale, a black longitudinal median line from the coxae to about two-thirds the length of the metasternum where it ends in a fork or this black line may reach nearly the apex of the metasternum, widened into a circular area at about two-thirds

its length, and again widened or not at its apical end; on either side a longitudinal black bar just inside the latero-ventral carina, reaching posteriorly nearly to the apex of the metasternum, anteriorly it reaches a greater length, measured from the level of the angle of the latero-ventral carina, than its length posterior to that point, sometimes with a greater or lesser interruption nearly reaching the anterior suture which bounds the metasternum. Mesostigmal lamina low and of nearly uniform heighth throughout.

Coxae pale, the second and third each with the anterior face broadly black. Legs pale, of all the species the most distinctly marked with darker though the general pattern is similar to that of *kahli*; second and third femora dark at base and all femora dark at apex, between base and apex each femur with two encircling bands of brown to black, these dark areas more extensive than the pale areas adjoining them; tibiae paler and clearer than femora, each dark at base, a narrow line of black on the ventral surface, widest on the first tibia.

Venation like that of *solutus*; stigma dark brown or black.

Abdomen seen from above: similar to that of *kahli,* 7 brown rather than black, and the dark colors on the preceding segments are slightly paler in *attenuatus*; 8–10 brown, darker to black on the base of 9 and the apex of 10, a pale ring occupying the basal fifth of 8. Seen from the side similar to that of *kahli,* except that the dark color, adjoining the pale ventral margin of each of segments 3–6 is paler and duller, so the ventral margin is less contrastingly colored but the dark color is more extensively extended from the dorsum to the ventral margin so the pale basal and pale anteapical areas of each segment are more widely separated in *attenuatus* than in *kahli*; on 8 only the extreme ventral margin is pale, this widened slightly and briefly just before it passes into the pale basal ring. Sternum of 1 pale; 3 pale at base, passing insensibly into very pale brown which fades quickly into pale at the anteapical pale area, then passing posteriorly into more or less distinct blue and then brown; 4–6 similar to 3, the dark (brown) progressively darker from the anterior to the posterior segments, and the faint blue, sometimes following the anteapical pale area on 3, growing fainter and disappearing on 5 or 6; 7 dark brown or black, restricted pale (blue?) at base and apex; 8–10 bright light blue. Appendages black.

Length of the wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .8, and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 1.7.

Female.—Labium as in the male; labrum black, a large dull yellowish rounded basal spot on either side, these spots very narrowly or scarcely separated in the median line; clypeus patterned as in *kahli* but the pale color on the front is a dull leaden blue or obscure.

Prothorax similar in color and shape to that of the male.

Thorax above like that of the male except that the black adjoining the middorsal carina is only about half as wide as in the male; side of thorax similar to that of the male except that the dark colors are slightly paler, the dark stripe on the second lateral suture is not or very slightly widened

below, and the dark color (brown) of the metinfraepisternum does not shade into black below. Metasternum pale, a black longitudinal median line from between the coxae posteriorly to about the level of the angle of the latero-ventral carinae; likewise the lateral dark area at the latero-ventral carina is less developed in the female than in the male, fading out into brown anteriorly and posteriorly, this brown fading imperceptibly into the general pale color.

Mesostigmal lamina as in the male.

Coxae pale, the third coxa with or without a brown area on the anterior face. Legs similar to those of the male, possibly slightly duller.

Venation and stigma similar to those of the male.

Abdomen seen from above: 1–4 similar to those of the male; 5 is narrowly pale at base, then very briefly black which fades into brown, which is continuous to just before the apical black where it fades into the restricted paler anteapical area (in the male the dark area which occupies the larger part of the segment darkens posteriorly from brown, just following the postbasal black to very dark brown or black just anterior to the anteapical pale area); 6 is largely pale or dark brown, the area adjoining the pale basal area being scarcely or not at all darker, the anteapical pale area poorly defined, and the apical area being only dark brown, not black; 7 brown, pale at base, scarcely if any darker at apex; 8 brown; 9 dark brown to black with a lateral basal blue spot on either side, patterned as in *kahli* but with the dark median longitudinal bar about .6 wide at base and 1.0 wide where it joins the dark apex; 10 dark brown, almost black. Seen from the side: 1–4 similar to those of the male; 5–7 paler than in the male, same as in dorsal view; 8–10 patterned as in *kahli,* 8 brown, shading to black at the extreme postero-ventral angle; dark colors on 9 black or nearly so, 10 black or nearly so. Sternum of 1 and 2 pale, 2 with a postbasal dark stretch occupying about one third the length of the segment; 3–6 similar to those of the male but without traces, or very faint ones, of anteapical blue; 7 dark to black, broadly pale at base and less definitely anteapically; 8 blue with a median black area as in *kahli.* Appendages dark brown to black, shaped like those of *magdalenae.* Valvular styles at their point of attachment at about the level of the middle of the appendages.

Venational characters based on four males and three females

Postnodals front wing, 11 (25% males), 12 (37.5% males, 33.3% females), 13 (25% males, 66.7% females), or 14 (12.5% males); hind wing, 10 (37.5% males), 11 (50% males, 33.3% females), 12 (12.5% males, 50% females), or 13 (16.7% females).

M_3 in front wing arising at the first postnodal (50% males, 16.7% females), or between the first and second postnodals (50% males, 83.3% females); in the hind wing at the first postnodal (62.5% males, 16.7% females), or between the first and second postnodals (37.5% males, 83.3% females).

Rs in front wing arising at the seventh postnodal (62.5% males, 16.7% females), or at the eighth postnodal (37.5% males, 83.3% females); in the

hind wing at the sixth postnodal (37.5% males), at the seventh postnodal (62.5% males, 83.3% females), or at the eighth postnodal (16.7% females).

M_2 in front wing arising at or near the eighth postnodal (62.5% males, 16.7% females), or at or near the ninth postnodal (37.5% males, 83.3% females); in the hind wing at or near the seventh postnodal (37.5% males), at or near the eighth postnodal (50% males, 83.3% females), or at or near the ninth postnodal (12.5% males, 16.7% females).

M_{1a} in front wing arising at the distal end of the stigma (100% males, 83.3% females), or at the proximal end of the stigma (16.7% females); in the hind wing at the distal end of the stigma (100% males, 100% females).

Number of cells posterior to Cu_2 in the front wing, 7 (12.5% males, 16.7% females), 8 (16.7% females), 9 (37.5% males), 10 (25% males), 11 (25% males, 16.7% females), or 12 (50% females); in hind wing, 3 (16.7% females), 4 (37.5% males, 16.7% females), 5 (62.5% males, 33.3% females), or 6 (33.3% females).

The following color notes were made from a male and female taken at Abuná, March 20. Male.—Eyes dull green above, slightly lighter below. Top of head metallic green with purplish reflections. Back of head metallic grays and browns. Prothorax brown and transparent light color. Narrow middorsal stripe light gray, bordered with black, in turn bordered with brown with metallic green reflections; a pearl colored antehumeral stripe; mesepimeron brown; posteriorly almost white with a brown stripe on the second lateral suture; very light below. Legs white with black markings. Abdomen black, brown and white, 7 and 8 with areas of pale blue. Female.—Similar, thoracic colors the same but paler; blue areas on abdominal segments 7 and 8 paler.

Material examined: *Bolivia,* Cashuela Esperanza, April 13, 1922, 1 male; *Brazil,* Abuná, Matto Grosso, March 16, 20 and 21, 1922, 4 males, 1 female; Porto Velho, Amazonas, May 2, 7, 18, 19, 23, and 24, 1922, 17 males, 2 females; Manáos, Amazonas, June 18, 1922, 2 males.

The reasons for assigning De Selys' name to the above species are as follows: 1. His description agrees well, except that the female described by him has the abdomen longer than any of the few females we have seen. (It must not be overlooked that De Selys' description is largely comparative with *cornutus,* though he speaks of it as *fragilis.*) 2. Our specimens are from widely scattered localities and there is no reason why the species should not be expected to occur at Santarem, the type locality. 3. Moreover, *attenuatus* seems to be rather adaptable for a Perilestes as it occurs on sandy bottom creeks and on creeks with mud bottoms and banks, so there is this further reason for expecting to find it at Santarem.

Attenuatus was the only species of Perilestes taken at Abuná, where it was found in woods along the creek at Km. 216. The first male seen was hanging with folded wings from the tip of a leaf eight feet above the ground; the second was flying in the woods a few inches from the ground. Likewise it was the only species taken at Cashuela Esperanza, where a single male was taken on a creek where two species of Heteragrion were common. At Porto Velho while *cornutus* was found only on the charcoal

burners' creek, two and one-half miles east of town, *attenuatus* was found not only on the same creek, but also on a creek crossed by the Rondon Telegraph Trail, and on a creek two feet deep and three to eight feet wide, with mud bottom and banks, flowing in a gully in the forest east of town. It was taken on this mud bed stream on May 19; on the same date *minor* was taken in the nearby jungle. At Manáos *attenuatus*, the only species found there, was taken on a mixed gravel and clay bedded stream in heavy forest beyond Flores.

6. **Perilestes kahli**, new species

Abdomen male 47–50, female 43; hind wing male 22–24, female 25; stigma front wing male 1.10–1.15, female 1.20; stigma hind wing male 1.20, female 1.30; abdominal appendage male 1.30–1.40, female .35; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.15–1.20; female valve 1.90.

Male.—Labium similar to that of *solutus*, the apical half or more of the movable hook black; face similar to that of *fragilis*, but the black on the apical part of the labrum is slightly produced basally in the median line and on the lateral margins.

Prothorax pale, only slightly darker above; hind border flattened, above straightened, slightly rising from either side to a little higher at the center, the lateral extremities almost vertical.

Thorax similar to that of *fragilis* with the black adjacent to the narrowly brown middorsal carina from about as wide as the antehumeral yellow stripe, (about two-fifths as wide as the reddish brown of the middle area of the mesepisternum) to fully occupying the area from the pale carina to the pale antehumeral stripe; mes- and metinfraepisternum extensively pale below and darker to black above to largely black with only the lower triangular area pale. Metasternum as in *fragilis* but the lateral dark areas may be the same or may be reduced and brown. Mesostigmal lamina low and straight above, the lower third elevated into a low symmetrical triangle.

Coxae pale, the third with or without the anterior face largely dark to black. Femora pale, marked more extensively with dark than in *fragilis* to such an extent in the case of the Bolivian male that the color pattern of the first and second femora is obscured by the extensive black; first femur pale at base, the apical two-fifths to four-fifths of the dorsum brown or black with or without a trace of a pale anteapical spot on the antero-dorsal surface, black continued on the antero-ventral edge to near the base, dorsal surface with trace of a brown postbasal area; ventral surface pale, shading to brown apically or the entire surface black; second femur pale at base and black at apex with two brown areas between, each of which is more extensive than the pale areas adjacent to it and nearly or quite encircles the femur, the anteapical pale color, on the antero-dorsal surface, is pale blue or green; or the second femur is black with only a small pale postbasal and a small pale anteapical area on the antero-dorsal surface; third femur similar to the pale form of the second described above, but the basal pale

area is wanting, being occupied by the brown area which is postbasal on the second femur. Tibiae distinctly paler than the femora, very light yellow, dark brown at base, marked as in *fragilis*.

Venation and stigma as in *solutus*.

Abdomen seen from above: 1 pale, only slightly darker above, the extreme apex brown, passing to black below; 2 black or brown, in the latter case pale at the base and passing into black at the extreme apex, in which case the brown is so pale basally that the median longitudinal pale area is ill defined in the dried specimen; 3–7 similar to those of *fragilis*, but slightly darker in the dark areas on the anterior segments and progressively more so on the posterior segments, so 7 is black with a pale basal ring; 8 black with the basal fourth or third pale (blue?), in the type specimen the black encroaching on the pale area in the median line with a triangular projection; 9 and 10 black. Seen from the side: 1–7 similar to those of *fragilis*, but differing as follows: on 2 the dorsal dark does not extend quite so far on the side on *kahli* and the line of separation of the dark and pale is a straight line, not a dorsally convex line as in *fragilis*; segments 3–7 have the dark areas darker in color in *kahli*, on the posterior segments becoming black rather than brown, and they differ strikingly from *fragilis* in having the ventral margins more extensively pale, due to a complete or more nearly complete joining along the ventral margin of the pale basal area and the anteapical pale area, on 3 this joining is complete, on 4 there is a slight brief shading of brown just before the anteapical pale area, on 5 this brown is darker and more extensive, on 6 the dorsal black reaches the ventral margin along about the middle half of the segment and is thus nearly as extensive as in *fragilis*; 7 entirely black, excepting the lateral extension of the pale basal ring; 8 with the pale basal spot narrowing posteriorly but reaching the apex along the ventral margin; 9 all black with the merest streak of pale on the ventral margin; 10 with the ventral half pale. Sternum of 1 pale; 3 dark, narrowed at the base, and interrupted at the anteapical pale area; 4 dark to black, pale at base and at the anteapical pale area; 5 black, pale at base with a brown spot, and pale at the anteapical pale area; 6 similar to that of 5 but the basal brown spot larger and darker; 7 black, very briefly pale at base and apex; 8–10 bright light blue. Appendages black.

Length of wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .8, and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 1.7.

Female.—Labium as in the male; labrum black, a large dull yellow median geminate spot at the base; clypeus in front dull yellow, a vertical brown bar on either side equally distant from the median line and the lateral margin; clypeus above black.

Prothorax similar to that of the male but darker above, a round dark brown median spot on the front lobe, and the dorsum of the middle and hind lobes, excepting the elevated hind border of the latter, dark brown to black; hind border similar to that of the male but slightly more elevated.

Thorax above with the dorsal black occupying one-half to two-thirds of

the mesepisternum, narrowly bordered along its outer edge with brown which fades into the pale but ill-defined antehumeral stripe; side of thorax as in the male, but the metinfraepisternum is entirely black except the lower nearly equilaterally triangular part. Metasternum as in the male but the lateral dark areas are larger and are black.

Mesostigmal lamina as in the male.

Coxae and legs similar to those of the male.

Venation similar to that of the male, the stigma slightly duller, less reddish, brown.

Abdomen seen from above: 1–5 similar to those of the male, but darker, the pale basal rings are as distinct as in the male but the anteapical pale area on each segment is less distinct, especially on the posterior segments, though the apical black, as distinguished from the color basal to it, is distinct in all; 6 and 7 brown, pale ringed at base, and very slightly darker at apex; 8 and 10 black; 9 distinctly patterned, slightly more than the basal half pale (blue?) with a black median longitudinal bar from the base passing into the black which occupies the apical part of the segment; this black bar is about .4 wide at the base and about .7 wide where it passes into the apical black. Seen from the side 1–5 are similar to those of the male; 6 brown, pale basally and thence along the ventral margin for a short distance, and with ill defined traces of pale on the ventral margin at the region of the anteapical pale area; 7 brown, darker at the postero-ventral angle; 8 and 10 black, the ventral margin of 8 pale, widest at the base and tapering apically, not quite reaching the apex; 9 pale (blue?) with a triangular black area in the antero-ventral angle and with apical black, narrowing from the dorsum to the extreme postero-ventral angle, the black at base and the black at apex with their opposing lines parallel, that is, the pale area cuts diagonally across the segment. Sternum of 1 pale; 2–5 dark to black, pale at base and anteapically; 6 similar to the preceding segments but apparently lacking the anteapical interruption; 7 black, pale at base and extreme apex; 8 blue with a small median longitudinal dark area which reaches neither base nor apex, and is widest at mid-length. Appendages black, shaped like those of *magdalenae*. Valvular styles at their point of attachment slightly distal to the level of the apex of 10.

Venational characters based on two males and one female

Postnodals front wing, 12 (25% males), 13 (50% males), or 14 (25% males, 100% females); hind wing, 11 (50% males), 12 (25% males), or 13 (25% males, 100% females).

M_3 in front wing arising between the first and second postnodals (100% males, 100% females); in the hind wing at the first postnodal (25% males, 100% females), or between the first and second postnodals (75% males).

Rs in front wing arising at the seventh postnodal (50% males), at the eighth postnodal (25% males, 100% females), or at the ninth postnodal (25% males); in the hind wing at the seventh postnodal (100% males, 100% females).

M_2 in front wing arising at or near the eighth postnodal (25% males), at or near the ninth postnodal (50% males, 100% females), or at or near the tenth postnodal (25% males); in the hind wing at or near the eighth postnodal (100% males, 100% females).

M_{1a} in front wing arising at the distal end of the stigma (100% males, 100% females); in the hind wing at the distal end of the stigma (100% males, 100% females).

Number of cells posterior to Cu_2 in front wing, 9 (25% males), 11 (25% males), 12 (50% males, 50% females), or 13 (50% females); in hind wing, 7 (50% males, 50% females), 8 (50% males), or 9 (50% females).

Material examined: *Brazil,* Villa Murtinho, Matto Grosso, April 1, 1922, 1 male; *Bolivia,* Rio Japacani, East Bolivia, J. Steinbach, Carnegie Museum, Acc. 5574, 1 male, 1 female. The Brazilian male, coll. E. B. W., the type, and the Bolivian female, coll. Carn. Mus., the allotype. Named for Mr. Hugo Kahl of the Carnegie Museum, to whom we are indebted for many kindnesses, the last of which was the loan of all the specimens of Perilestes in the collections in his charge. Moreover, before this material was sent us, Mr. Kahl had studied the two Bolivian specimens and was unable to refer them to any described species.

The single Brazilian specimen was taken at the creek at Km. 315 south of town. Associated with it on the same creek were the rare *cornutus* and the relatively abundant *solutus.*

7. *Perilestes fragilis* Hagen

Abdomen male 50–52, female 50; hind wing male 25–26, female 27.5; stigma front wing male 1.35–1.60, female 1.50; stigma hind wing male 1.40–1.60, female 1.60; abdominal appendage male 1.50, female .40; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.30–1.40; female valve 1.85.

Male.—Labium similar to that of *solutus,* apical parts not quite as dark; labrum light blue, almost white, a straight black bar on the anterior border, occupying about one-third the labrum; anterior surface of the clypeus same color as basal two-thirds of labrum, dorsal surface black, the line separating the two colors smooth.

Prothorax similar to that of *solutus* in color and shape.

Thorax brown above with greenish reflections, shading to black along the middorsal carina which is very narrowly light brown; a pale yellow antehumeral stripe about .2 wide not reaching the upper end of the mesepisternum; mesepimeron reddish brown; metepisternum yellow or yellowish, with a dark brown stripe along the second lateral suture which widens above to extend across the sclerite while below it is carried across the metinfraepisternum by a broad area which includes all but the inferior angle of that sclerite; metepimeron yellow or yellowish, the same color as the metepisternum. Metasternum pale, with a median black line as in *solutus* and, in addition, with a black area on either side in the angle of the latero-ventral carina.

Mesostigmal lamina above low, gradually rising to near the lower end where it is rounded off so the lower third is symmetrically convex.

Coxae pale, the third pair with a small black area on the anterior face. Femora pale yellowish, slightly tinged brownish at the base, and distinctly black at the apex with two intermediate brownish rings or areas, about equally spaced, and each about the same extent as each of the three pale areas thus formed, the basal of these two darker areas the paler and less distinct; ventral surface black in the median line except at the base of the first femur and the apices of all. Tibiae pale like the femora, the first tibia with a narrow black line beneath, widening and more distinct at the comb, this line a mere trace on the second and third tibiae; a basal streak of brown on the dorso-anterior surface of all the tibiae, most distinct on the first, scarcely evident on the third.

Venation like that of *solutus*; stigma black.

Abdomen seen from above: 1 and 2 similar to those of *solutus*, but the median longitudinal pale bar on 2 shorter, only about two-thirds the length of the segment; 3–7 each with an obscure pale basal ring, darkest and least evident on 3, followed by brown which darkens posteriorly, becoming black on 4–6; 3–6 with this dark on each segment fading posteriorly into pale which in turn darkens into an apical black area about twice as extensive as the pale area which precedes it; 3–8 each with or without a median longitudinal thread line of pale which disappears before the apex of 8; 7 uniformly dark brown after the obscure pale basal ring, tending toward black along the middorsum; 8–10 dark brown, 8 the palest of the three, and 10 nearly or quite black. Seen from the side: 1 and 2 are similar to those of *solutus*; 3–6 each pale at base and subapically along the ventral margin, these pale areas extending toward each other along the extreme ventral margin, and obscurely joined on 3, but progressively more widely separated from 4 to 6 by the lateral extension of the large median dark area; 7 pale at base, then brown, the extreme apex usually darker; 8 with the entire side fading out to light bluish along the extreme ventral margin; 9–10 black, 9 with the merest line of pale on the ventral border. Sternum of 1 pale; of 3 pale with a longitudinal streak, narrow and darkest at the base, then widening and fading out before the middle of the segment, darkening again to black in the apical black of the tergum; 4–6 each with the sternum pale at base, then darkening through brown to black which fades out to pale at or before the subapical pale area of the tergum, the apex as in segment 3; in life the pale areas on the sterna of 3–6 doubtless show more or less blue; 7 black, extreme base and apex apparently blue; 8–10 heavily pigmented, bright blue (or possibly yellow) in life. Appendages white to brown, the external edge brown to black.

Length of wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .8 and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 1.7.

Female.—Labium as in the male; labrum yellowish brown, the apical half and the lateral margins black; clypeus in front greenish, a large brown area in the middle of each side, above dark brown to black.

Prothorax as in the male.

Thorax similar to that of the male, the antehumeral yellow stripe very slightly wider.

Mesostigmal lamina similar to that of the male.

Legs similar to those of the male, the basal streak of brown on the dorso-anterior surface of the tibiae scarcely evident in the female.

Venation similar to that of the male.

Abdomen seen from above: 1 and 2 similar to those of the male but 1 paler at base; 3 black following the pale basal ring, fading out through brown beyond the midlength of the segment to the anteapical pale, the apical 1.5 m.m. black as in the male; 4 and 5 similar to 3; 6 brown rather than black postbasally, and the segment nearly uniformly colored, the apical black and anteapical paler areas scarcely distinguishable; 7 and 8 similar to 6, slightly darker, the pale basal ring reduced on 7 and wanting on 8; 9 yellowish brown, narrowly and indefinitely black in the midline and on the apical edge, dark brown to black on either side apically, these lateral dark areas widely separated by the paler dorsal color; 10 black. Seen from the side 1 and 2 are similar to those of the male; on 3 and 4 the basal and subapical pale areas are joined along the ventral border but on 5 the median dark of the tergum separates them and on 6 the subapical pale area is scarcely or not distinguishable and the postbasal pale area is continued very briefly along the ventral margin; 7 and 8 brown, slightly paler toward the ventral margin and basally on 7 and a small ventro-posterior brown area on 8; 9 pale yellowish brown, lightest along the ventral margin, apically dark brown or black for a width of about one-third m.m., this black narrowing ventrally, and with a small ventro-anterior brown area; 10 black. Sternum of 1 pale; 2 pale with a postbasal and an apical black or brown area; 3–6 similar, with the postbasal dark area on each extensive, occupying half the length of the sternum or more; 7 pale at base, then dark, apparently without an anteapical pale region; 8 pale (probably blue in life) with a narrow longitudinal median black line scarcely reaching base or apex and widest at about midlength of the sternum. Appendages black, shaped like those of *magdalenae*. Valvular styles at their point of attachment distal to the level of the apex of 10.

Venational characters based on three males and one female

Postnodals front wing, 13 (33.3% males), or 14 (66.7% males, 100% females); hind wing, 10 (16.7% males), 12 (66.7% males, 50% females), 13 (16.7% males), or 14 (50% females).

M_3 in front wing arising at the first postnodal (50% males, 100% females), or between the first and second postnodals (50% males); in the hind wing at the first postnodal (100% males, 100% females).

Rs in front wing arising at the eighth postnodal (50% males, 100% females), or at the ninth postnodal (50% males); in the hind wing at the sixth postnodal (33.3% males), or at the seventh postnodal (66.7% males, 100% females).

M_2 in front wing arising at or near the ninth postnodal (33.3% males, 100% females), or at or near the tenth postnodal (66.7% males); in the

hind wing at or near the seventh postnodal (16.7% males), or at or near the eighth postnodal (83.3% males, 100% females).

M_{1a} in front wing arising at the proximal end of the stigma (83.3% males), or one cell proximal to the stigma (16.7% males, 100% females), in the hind wing at the distal end of the stigma (33.3% males), or at the proximal end of the stigma (66.7% males, 100% females).

Number of cells, posterior to Cu_2 in front wing, 10 (50% females), 11 (16.7% males), 12 (33.3% males), 14 (50% females), 15 (33.3% males), or 16 (16.7% males); in hind wing, 6 (16.7% males), 8 (16.7% males, 100% females), 9 (16.7% males), 10 (16.7% males), 11 (16.7% males), or 12 (16.7% males).

Material examined: *Brazil*, Rio de Janeiro, Alto Boa Vista Creek, below Alto Boa Vista, September 6 and 8, 1922, 3 males; Cascatinha Falls Creek, above Alto Boa Vista, September 14, 1922, 1 female.

The larger of Hagen's two female types of *fragilis* was taken at Congonhas, Brazil, a town about 250 miles north and a little west of Rio de Janeiro, and on the headwaters of the Rio San Francisco. This larger female type rather than the smaller female from the Essequibo in British Guiana, is the basis for Hagen's generic and specific description. The description agrees well with the Rio female, and unless later collecting should reveal more than one species in the locality, the determination of the Rio specimens as *fragilis* may be considered certainly correct. Because of the wide separation of the locality from the Amazonian basin, it is improbable that more than one species will be found near Rio in the future.

8. Perilestes solutus, new species

Abdomen male 42–46, female 38–40; hind wing male 20–21, female 21–24; stigma front wing male 1.13–1.20, female 1.27–1.33; stigma hind wing male 1.12–1.20, female 1.27–1.30; abdominal appendage male 1.20–1.35, female .40; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.35–1.45; female valve 1.85–2.0.

Male.—Labium pale, apices of median lobe, end hook and movable hook shaded darker; labrum, anteclypeus and the postclypeus narrowly in front and with or without a deep median rectangular indentation, bright blue, the labrum narrowly black margined in front.

Prothorax pale, darker shaded above especially on the middle and hind lobes, the procpimeron largely light brown; hind border semicircular.

Thorax black above with greenish reflections, the dark occupying about half or more of the mesepisternum, the middorsal carina narrowly brown; outer half or less of mesepisternum, except the extreme upper part which is black, pale brown or dark flesh with traces of bluish or yellowish; this pale color may fade out to a maximum along the humeral suture or there may be a well-defined narrow pale antehumeral stripe; mesepimeron reddish brown, a long black spot above on the humeral suture and another shorter one above and posterior to it, with a pale (yellow?) area between them; the broad band of color of the mesepimeron carried across the mesin-

fraepisternum; metepisternum pale, flesh colored below and yellowish above and behind where there is a black stripe along the second lateral suture; at midheighth this black stripe is about .1 wide, above it leaves the suture and angles obliquely forward and upward about half across the upper end of the metepisternum, below it ends against the metinfraepisternum; metepimeron pale flesh, almost white, bright rust colored below, this color continued across the upper part of the metinfraepisternum where it passes, at the extreme antero-ventral angle, into black. Metasternum pale like the metepimeron, a black longitudinal median line from the hind coxae posteriorly to nearly the level of the angle in the latero-ventral carina.

Mesostigmal lamina very slightly concave above throughout its length, at its outer end produced into a free triangular outwardly directed point.

Coxae pale, the third pair shaded a darker rust color on the anterior face. Femora pale, tinged yellowish or reddish, black at the apex, this black carried basally a third to a half the length of the femur on the anterior face of the first and second femora, the first femora the darker. Tibiae pale reddish like the femora, the anterior face paler and yellowish rather than reddish.

Venation black, veins shading out to light brown at the wing base; stigma reddish brown (Sanford's brown, Ridgway).

Abdomen seen from above: largely dark to black with restricted pale markings; 1 with a narrow median longitudinal black bar, joined at the apex with a narrow black transverse ring; 2 with a corresponding but wide black bar which laterally extends far below the level of the black on 1 and to the level of the black on 3, a narrow median longitudinal pale bar from base to about four-fifths its length; 3–7 black, each with a narrow transverse pale blue or yellowish basal ring and a pale median dorsal stripe extending posteriorly from it, nearly to the apex on 3, and successively narrower and shorter posteriorly till on 7 it is scarcely evident or may occupy as a maximum one-third the length of the segment; 8–10 unmarked, with restricted traces of paler color on the base of 8. Seen from the side: 1 pale except the dark apical ring; 2 with about the ventral half pale, the ventral pale and dorsal black areas meeting in a nearly straight line; 3–7 each with the ventral margin narrowly pale from the base, where it joins the pale basal ring, to near the apex; 8 has a pale ventral border from base to apex but in this case the color is distinctly blue, not merely pale or yellowish as on 3–7, though in life 7 at least may show the same blue color; 9 has the extreme ventral edge blue, 10 is blue below, the dorsum black. Sternum of 1 pale; of 3 pale with a longitudinal black streak, widening into a bar, from the base to near the apex of the lateral pale color of the tergum where it fades out to again reappear in the apical black of the tergum; or the dark color may extend continuously from base to apex without any pale interruption; 4–6 similar, but there may or may not be a short postbasal interruption of the black streak of about the same extent as the anteapical interruption; 7 blue with a median streak corresponding to that on 6, but lacking in the apical part; 8–10 blue, densely pigmented, usually faded to

leaden grey in dried specimens. Appendages black, at thin places dark reddish horn showing through.

Length of the wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .8, and the distance from the apex of this lobe to the antero-ventral angle of the tergum about 1.8.

Female.—Labium as in the male; labrum and clypeus brown, the labrum narrowly black margined in front and the anteclypeus with a median spot and the lateral margin pale (bluish?).

Prothorax as in the male.

Thorax similar to that of the male with the following differences: mid-dorsal black reduced to a median bar about .5 wide, bordered on either side with broader brown, fading out into a pale bar along the suture, the latter probably blue in life; mesepimeron lacking the dorsal posterior black spot of the male; the bright rust less evident on the metepimeron. Meso-stigmal lamina similar to that of the male.

Coxae similar to those of the male, the rust color scarcely evident on the third pair. Femora similar to those of the male, slightly paler and less reddish. Tibiae pale yellowish, the first pair dark beneath along the comb.

Venation similar to that of the male; stigma slightly duller.

Abdomen seen from above similar to that of the male with the following differences: dorsal bar on 1 fading out and disappearing at the base: on 3–5 the dark dorsal area on each segment is black only at its base against the basal blue ring, shading at once posteriorly into brown, which brown darkens anteapically into black which is more extensive than the basal black; 6 is brown throughout in the dark area, without black, but the apex darker; 7–10 brown, 9 darker, each side with a large lateral blue spot, the brown between them at base about .8 wide; in dorsal view the blue spot disappears at about two-thirds the length of the segment. In side view 1–5 patterned about as in the male but duller; 6 brown, except the pale base which is carried along the ventral border a short and indefinite distance; 7, 8 and 10 brown; 9 largely blue, the antero-ventral area brown, and apically the brown dorsum is carried onto the side in an obscure ill-defined pattern, but does not reach the ventral margin which is pale throughout except at the base. Sternum of 1 pale; 2–5 each similar to 3 of the male; 6 and 8 each similar to 5 but no anteapical fading out of the black; 7 is like 6 or has the black fading out at the apex. Appendages black, flattened cone-shaped, acute, similar in shape to those of *magdalenae*. Valvular styles at their point of attachment at about the level of the apex of 10 or very slightly more proximal.

Venational characters based on four males and four females

Postnodals front wing, 11 (100% males), 12 (25% females), 13 (62.5% females), or 14 (12.5% females); hind wing, 10 (25% males), 11 (75% males, 12.5% females), or 12 (87.5% females).

M_3 in front wing arising at the first postnodal (75% males, 50% females), or between the first and second postnodals (25% males, 50%

females); in the hind wing at the first postnodal (62.5% males, 87.5% females), or between the first and second postnodals (37.5% males, 12.5% females).

Rs in front wing arising at the sixth postnodal (87.5% males, 25% females), at the seventh postnodal (12.5% males, 62.5% females), or at the eighth postnodal (12.5% females); in the hind wing at the fifth postnodal (12.5% males), at the sixth postnodal (87.5% males, 75% females), or at the seventh postnodal (25% females).

M_2 in front wing arising at or near the seventh postnodal (100% males, 25% females), or at or near the eighth postnodal (75% females); in the hind wing at or near the sixth postnodal (25% males, 12.5% females), at or near the seventh postnodal (75% males, 75% females), or at or near the eighth postnodal (12.5% females).

M_{1a} in front wing arising one cell distal to the stigma (25% males), at the distal end of the stigma (75% males, 50% females), at the proximal end of the stigma (37.5% females), or one cell proximal to the stigma (12.5% females); in the hind wing one cell distal to the stigma (37.5% males), at the distal end of the stigma (62.5% males, 87.5% females), or at the proximal end of the stigma (12.5% females).

Number of cells posterior to Cu_2 in front wing, 9 (12.5% males, 12.5% females), 10 (12.5% males), 11 (37.5% males, 25% females), 12 (37.5% males, 25% females), 13 (12.5% females), or 14 (25% females); in hind wing, 7 (12.5% males), 8 (75% males, 75% females), or 9 (12.5% males, 25% females).

The following living color notes were made from a male taken at Villa Murtinho: Eyes black above, passing into blue which in turn shades out to gray-green below; top of head metallic green. Face markings pale blue. Middorsal carina narrowly light brown, dorsum dark metallic green, bordered on either side with blue; mesepimeron brown with reddish reflections; metepisternum light green; metepimeron very pale blue; below translucent yellow and reddish brown. Legs reddish brown, dark brown at joints. Abdomen above black with white or light blue basal rings; sides brown, with blue on 2 and with blue basal rings; beneath light and dark brown with some bluish on 7 and 8–10 light blue.

Material examined: *Brazil,* Chapada, Matto Grosso, H. H. Smith, 2 males, 2 females (Calvert, Od. Neotropical Region), coll. Carn. Mus.; Villa Murtinho, Matto Grosso, creek at Km. 310 north of town, March 30 and April 3 and 7, 1922, creek at Km. 315 south of town and on a small tributary of it, March 31 and April 1, 4 and 6, 1922, and at the next creek south of the creek at Km. 315, March 31, 1922, a total of 50 males and 13 females, type male and allotype female taken April 4, 1922, on a small tributary, about one foot wide and a few inches deep, of the creek at Km. 315; Belém, Pará, igarpé beyond Souza car line, August 14, 1922, 1 male; all the specimens except those from Chapada in coll. E. B. W.

At the creek at Km. 315 the three species of Perilestes taken at Villa Murtinho were found together, but while *solutus* was relatively abundant

only a single male of *kahli* and two males of *cornutus* were taken. Moreover the last two species were not taken elsewhere at Villa Murtinho.

Specimens of both sexes of *solutus* may be specifically recognized at once by the free, outwardly directed inferior end of the mesostigmal lamina, the character to which the specific name refers.

9. **Perilestes minor,** new species

Abdomen male 40–41; hind wing male 20; stigma front wing male 1.10–1.20; stigma hind wing male 1.20–1.30; abdominal appendage male 1.20; male anterior lamina from apex of sternum of segment 1 to apex of the posterior process 1.30.

Male.—Labium as in *solutus*; labrum black, narrowly blue across the base, this blue indented at the middle with a rounded backward projection of the black; anterior surface of the clypeus bright blue, the dorsal surface black, the line separating the two colors smooth.

Prothorax similar to that of *solutus,* but the proepimeron pale like the adjacent parts.

Thorax similar to that of *solutus,* the dorsal black wider, and with the lateral margins convex rather than straight as in *solutus,* above adjacent to the antealar sinus fading out to brown; the pale color on the mesepisternum, adjacent to the humeral suture, is reduced to about half the width or less of the corresponding pale area in *solutus,* and is scarcely .3 wide; side of thorax similar to that of *solutus,* but the black superior spot on the humeral suture is less marked in *minor,* and the spot posterior to this spot in *solutus* is wanting in *minor.* Beneath similar to *solutus* but the dark line on the metasternum reduced to an anterior black spot and a posterior brown spot.

Mesostigmal lamina nearly straight above, the lower end an acute nearly right-angled angle, this angle the homologue of the projecting point which characterizes *solutus.*

Coxae pale. Femora pale, extensively dark marked as follows: largely black beneath, reduced toward the base, apically extending more or less onto the anterior surface, dorsal surface with base and apex dark shaded and with two transverse brown bands, the five bands of light and dark between base and apex thus formed are subequal in extent; this pattern present but not as well marked on the first femur. Tibiae pale yellowish, black beneath on the first tibia along the comb.

Venation similar to that of *solutus*; stigma brown to black, no trace of the reddish brown which is well marked in that of *solutus.*

Abdomen seen from above: 1 pale brown, obscure and scarcely darker than the pale sides, this brown interrupting the apical black ring in the midline; 2 brown, slightly or scarcely darker at base and more distinctly so at apex, the two darker areas and the included paler area about equal in extent; 3–6 each with a narrow transverse basal pale blue ring, followed by brown which passes subapically into a narrow pale ring which is succeeded by the two or three times more extensive apical black; the extensive brown area of each segment is darker, progressively from 3–6, until on

6 it is nearly or quite black and the anteapical pale area is almost obliterated; on 3–6 the pale narrow median longitudinal stripe, present in *solutus*, is entirely wanting in *minor*, except for the merest trace of it on 3; 7 with a transverse basal ring, homologous and similar to that of the preceding segments, followed by brown or by black or almost black which passes into dark brown at the apex; 8–10 similar to those of *solutus*. Seen from the side, 1 and 2 patterned as in *solutus*, dorsum of 2 brown, not black as in *solutus*; 3–6 with the pale basal ring produced posteriorly along the ventral border for only a short distance if at all, thus differing from *solutus*, but in *minor* the subapical pale spot, which in *solutus* is only the slightly more distinct apex of the pale ventral margin, is larger and is produced dorsally, while in *solutus* it is not so produced at all; on 6 the subapical pale area is obscure; 7 has a pale basal area and the ventral margin very narrowly pale, with this pale color widened very slightly subapically but not visible in dorsal view; 8 with a narrower pale basal ring but with the ventral margin broadly and distinctly pale for its entire length; 9 entirely dark to nearly black, the merest line of pale color on the extreme ventral margin; 10 largely blue, only the dorsum dark. Sterna of 1 and 3 similar to those of *solutus*, but brown on 3, rather than black; on 4–5 pale at base, shading into brown which is interrupted at the subapical pale spot of the terga; on 6 pale at base, shading into black which is continuous to the apex or may be narrowly interrupted subapically; on 7 broadly blue at base and more broadly blue at apex, the intermediate region irregularly blotched with black; 8–10 entirely bright blue. Appendages colored as in *solutus*.

Length of the wing or lobe on the expanded postero-ventral margin of the tergum of 2 about .7, and the distance from the apex of the lobe to the antero-ventral angle of the tergum about 1.6.

Venational characters based on two males

Postnodals front wing, 10 (25%), 12 (25%), or 13 (50%); hind wing 10, (50%), 11 (25%), or 12 (25%).

M_3 in front wing and hind wing arising between the first and second postnodals (100%).

Rs in front wing arising at the sixth postnodal (25%), at the seventh postnodal (50%), or at the eighth postnodal (25%); in the hind wing at the sixth postnodal (50%), or at the seventh postnodal (50%).

M_2 in front wing arising at or near the seventh postnodal (25%), at or near the eighth postnodal (50%), or at or near the ninth postnodal (25%); in the hind wing at or near the seventh postnodal (50%), or at or near the eighth postnodal (50%).

M_{1a} in front wing arising at the distal end of the stigma (50%), or at the proximal end of the stigma (50%); in the hind wing at the distal end of the stigma (100%).

Number of cells posterior to Cu_2 in front wing, 11 (75%), or 12 (25%); in hind wing, 9 (100%).

Material examined: *Brazil*, Porto Velho, Amazonas, May 19, 1922, 2 males, one of these the type, coll. E. B. W.

The only two known males of this species were taken east of Porto Velho where the woods trail crossed a low stretch of ground. In January there was running water here but in May this had disappeared though the creek bed was damp and rankly overgrown, and only by stooping and crawling could one still follow it. In this jungle, associated with *Subaeschna francesca, minor* was captured.

The male abdominal appendages of *minor* are strikingly like those of *solutus,* from which species it is separated at once by the color of the face and the abdominal pattern, especially of segments 3–5. *Minor* is the smallest known species of the genus.

PLATE I

Supero-internal views of the left superior appendage of the males of the species of Perilestes.

1. *P. cornutus,* Porto Velho, May 2, 1922; 2. *P. guianensis,* type male; 3. *P. remotus,* type male; 4. *P. magdalenae,* type male; 5. *P. attenuatus,* Porto Velho, May 7, 1922; 6. *P. kahli,* type male; 7. *P. fragilis,* Rio de Janeiro, September 14, 1922; 8. *P. solutus,* type male; 9. *P. minor,* type male.

1. P. cornutus

2. P. guianensis

3. P. remotus

4. P. magdalenae

5. P. attenuatus

6. P. kahli

7. P. fragilis

8. P. solutus

9. P. minor

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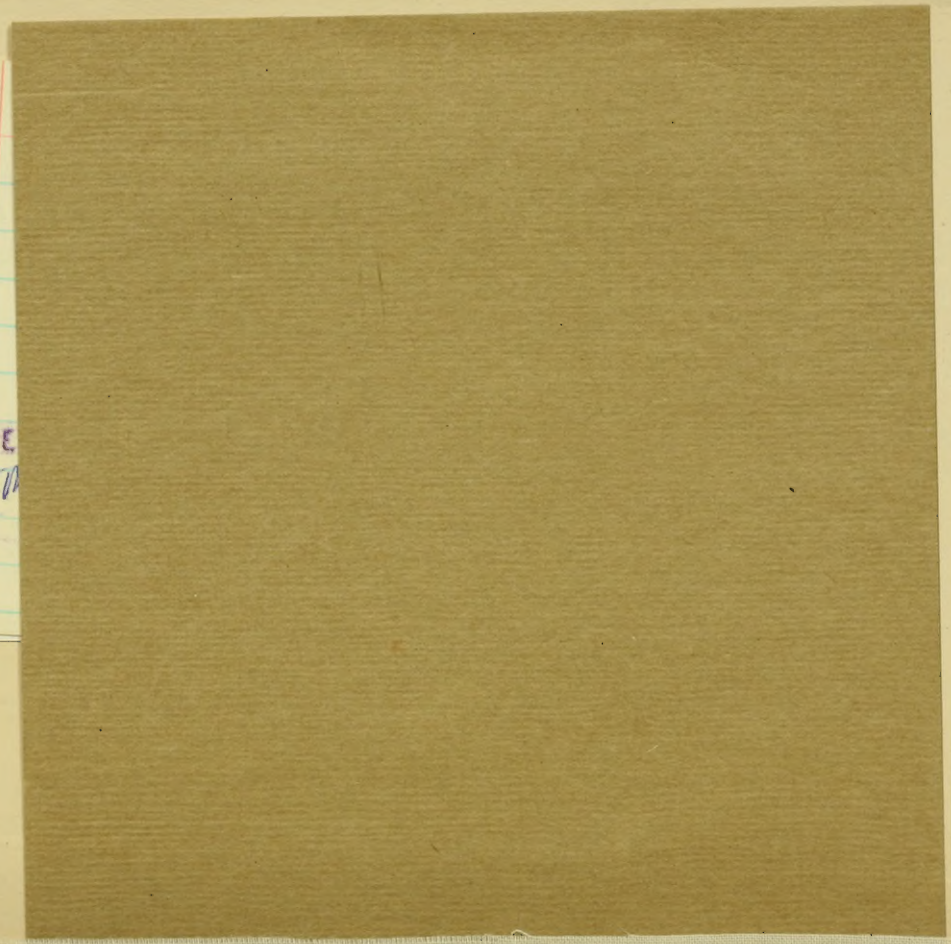

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